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"A Serological and Ectoparasite Survey of Migratory Birds in Northeast Africa"

Final Report

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13. ABSTRACT A survey of migratory birds, their ectoparasites and the viruses they carry, was conducted in the eastern Mediterranean from 1966 to 1971. The primary operation site has been in northern Egypt, with one year of operation in Cyprus and two years (bird banding and tick collection only) in Israel. Nearly 100,000 birds have been handled; the records from eighty per cent have been computerized and are under study. More than 4,400 individual ticks were collected including two new species. Between 1966 and 1968, 3,890 individual and pooled blood samples were collected from 6,152 birds. 54 mouse pathogenic agents representing 7 groups have been isolated from them demonstrating that migrating birds can transport live virus between continents. At least four strains are new. One, Bahig in the Tete Group, has been characterized; the others, including Matruh in the same group, are under continuing study. Blood samples from later seasons are frozen awaiting study but passages of 14 mouse pathogens from 646 erythrocyte specimens collected in fall, 1969 are frozen for definitive characterization. No viruses were isolated from ticks during the study. Serological tests revealed prior infection of migratory and resident birds with a number of viruses.

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Abstract

A survey of migratory birds, their ectoparasites and the viruses they carry, was conducted in the eastern Mediterranean from 1966 to 1971. The primary operation site has been in northern Egypt, with one year of operation in Cyprus and two years (bird banding and tick collection only) in Israel. Nearly 100,000 birds have been handled; the records from eighty per cent have been computerized and are under study. More than 4400 individual ticks were collected including two new species. Between 1966 and 1968, 3890 individual and pooled blood samples were collected from 6152 birds. 54 mouse pathogenic agents representing 7 groups have been isolated from them demonstrating that migrating birds can transport live virus between continents. At least four strains are new. One, Bahig in the Tete Group, has been characterized; the others, including Matruh in the same group, are under continuing study. Blood samples from later seasons are frozen awaiting study but passages of 14 mouse pathogens from 646 erythrocyte specimens collected in fall, 1969 are frozen for definitive characterization. No viruses were isolated from ticks during the study. Serological tests revealed prior infection of migratory and resident birds with a number of viruses.

Introduction

The large volume of bird migration in the eastern Mediterranean is a well known phenomenon. Studies in disease transmission, particularly those caused by arthropod-borne viruses (arboviruses), and the pattern of distribution of virus outbreaks and isolations suggested a pattern compatible with migratory birds acting as vectors. By 1966, although the copious arborvirus literature had documented many instances of wild birds, several of which were migratory species, in an active viremic state, there was no published proof that birds were capable of actively carrying virus in their blood between continents. Likewise although there was ample proof that ticks and other blood-sucking ectoparasites were capable of transmitting live virus between vertebrate hosts, there was no proof that a migratory bird had carried a tick between continents that was capable of infecting other birds with an arbovirus. Most of the virus studies had been carried out intensively on either the birds' breeding or wintering grounds in foci of virus activity. It therefore remained to investigate birds midway on their migration through an extensive survey of the birds and their migratory routes, the ectoparasites they carried and their blood serology. A combination of factors lead to the selection of Egypt as a site of primary concentration. The principal investigator had made intensive ecological and systematic studies of birds in the eastern Mediterranean. The United States Naval Medical Research Unit 3 (NAMRU-3) in Cairo could provide good logistic and administrative support for such work and had scientists actively interested in arbovirology.

Northern Egypt was functionally a welcome island to weary migrants between the desert to the south and the Mediterranean to the north. A collaborative research program, the Palearctic Migratory Bird Survey (PMS), was therefore instituted in the summer of 1966, involving scientists of the Smithsonian Institution and NAMRU-3. It was decided to include the Yale Arbovirus Research Unit as the third member of the team effort because of its past association with both other institutions and because of its outstanding past work in the field. Funding was provided for three years, subsequently extended to four years, by ARPA through the Army Surgeon General's Office and by the Smithsonian Foreign Currency Program. A fifth year of support has been made possible jointly by the Smithsonian Research Foundation and Smithsonian Foreign Currency Program.

The Smithsonian group was adopted on a guest investigator status by the Department of Medical Zoology at NAMRU-3 and operated simultaneously with two Americans hired through Washington and an Egyptian staff hired partly through NAMRU-3. All went relatively smoothly for two migratory seasons until June 1967 when the outbreak of hostilities forced NAMRU-3 to temporarily suspend operations in Egypt and the Smithsonian to move its bird study to Cyprus. In the fall of 1968, however, we were able to return to Cairo and with some restrictions to resume the survey. The field work continued until the beginning of the fall season 1970 when field work was discontinued because of security in the area of operation. Thus, we had six migration periods of study in Egypt and two in Cyprus during the four years.

This report is divided into three sections representing the areas of interest of the three units. The first covers the Smithsonian's work with the birds of Egypt and Cyprus; the second covers the ectoparasites, especially NAMRU-3's study of the ticks, and the third deals with the virus work at YARU.

An appendix presents much of the background for interpretation of the results of the Survey. This includes distribution maps and habitat information on the species of birds examined, distribution maps of the ticks and arboviruses, records of birds recovered during banding and summary computer printouts of the birds examined and banded on each day during the Survey.

Eastern Mediterranean Bird Migration

Although bird migration between Eurasia and Africa has been studied for many years, data are few and inprecise for the eastern Mediterranean and Near Eastern sector Not only have few ornithologists made long-term studies east of Italy and Tunisia, but no major long-term bird banding was done in any country prior to the PMS. Even so, Moreau's (1961) efforts at syntheses of the widely scattered information on trans-Mediterranean and trans-Sahara migration has added immensely to understanding both of the total picture of migration and on the routes taken by and dates of passage of individual species. Moreau's major thesis is that most birds are capable of flying across the Mediterranean and the entire Sahara desert without "refueling". The birds that are seen on intermediate stops such as at islands, oases and on the Mediterranean coast may have been forced down by exhaustion or by unfavorable weather rather than to seek food. His conclusion is that the vast majority of Eurasian birds migrate on a broad front rather than following favored routes such as the Nile Valley. The storks and birds of prey are conspicuous exceptions.

The literature on eastern Mediterranean migration is summarized in Moreau (1961) and will again be reviewed in a posthumus book, in press, by the same author. Migration reports, many anecdotal by persons stationed for short periods in Egypt, have been published in the Bulletin of the Zoological Society of Egypt and in the Ibis. Moreau and Dolp (1970) have analyzed fat reserves of migrants in order to evaluate the energy needs of migrating birds.

Materials and Methods

The Mediterranean Sea and the Sahara Desert lie between the arctic and temperate breeding grounds of Palearctic birds and their tropical African wintering grounds. On migration, except for stops at some oases, most birds probably fly non-stop over the entire desert and their fat reserves appear to be sufficient for the 900-1300 mile journey which is estimated to take 30-40 hours southward and 50-60 hours northward (Moreau and Dolp, 1970). Likewise the Mediterranean is unhospitable as a landing place or feeding ground for terrestrial migrants except on a few islands. A narrow coastal fringe of the desert in northern Egypt, however, in addition to the Nile River Delta and Valley, provide enough cover and suitable habitat to permit resting and in some cases probably minimal feeding for some migrants. For those passing south it is the first landfall after crossing the Mediterranean, while during the spring it constitutes the first greenery after a long flight over the desert, as well as the last land before a long trip over the open sea. The fringe is attractive to migrants at both seasons and for many years large numbers of birds have been captured at certain favored sites for market. The PMS took advantage of this existing commercial situation to obtain large numbers of migrants. All of the major capture points (from west to east: Mersa Matruh, Burg El Arab, Bahig, Ikingi Mariut, and Port Said) for birds that had blood and tick samples collected or were banded, were in this pseudo-Mediterranean coastal belt or maritime plain.

Although this narrow belt receives only about four inches of rain, all of it during the winter, this, and the moisture-laden, on-shore breezes that blow all year, are sufficient to transform the coastal fringe of the desert into a strip with relatively copious vegetation. This strip, which is in most areas usually less than five miles wide but locally may penetrate further south, is present all along the northern Egyptian coast from Libya to Alexandria, and after interruption by the luxuriant irrigated farmland of the Delta, resumes in the northern Sinai.

A typical cross-section such as at Burg El Arab and Bahig consists of four zones (Figure 1). The northernmost zone is a sandy beach 100-200 yards wide sloping up to grassy dunes and a rock ridge (Figure 5). The second is a wider (700 yards) flat zone of dry, open desert fig groves, tamarisk bushes, and scattered Bedouin homes (Figure 2). The third is a broad salt bed with *Salicornia* lying between two rock ridges, representing an old beach when sea level was higher in the past. The salt beds are mostly dry but locally there is standing water, the remnants of former freshwater lakes in classical times. The fourth is a flat area of small villages and gardens with low olive, almond, carob, tamarisk and Australian Pine trees, and locally small fields of sparse barley that grow during the winter rains but are parched by summer (Figure 3). This last zone merges gradually into the true desert (Figure 4), although irrigation canals from the Aswan Dam project are beginning to alter the terrain and locally extend the area of irrigated agriculture. Quail were trapped mainly in the grassy dune and fig zones while most of the bush - and tree - frequenting species were taken in the garden belt.

Birds were captured by Bedouins in a number of nets and traps and with bird lime. Quail tend to hide at the base of a fig tree and most of the trees have nets (Figures 5 and 6). Huge numbers of quail are taken each year, and being a particularly tasty and meaty species, command premium

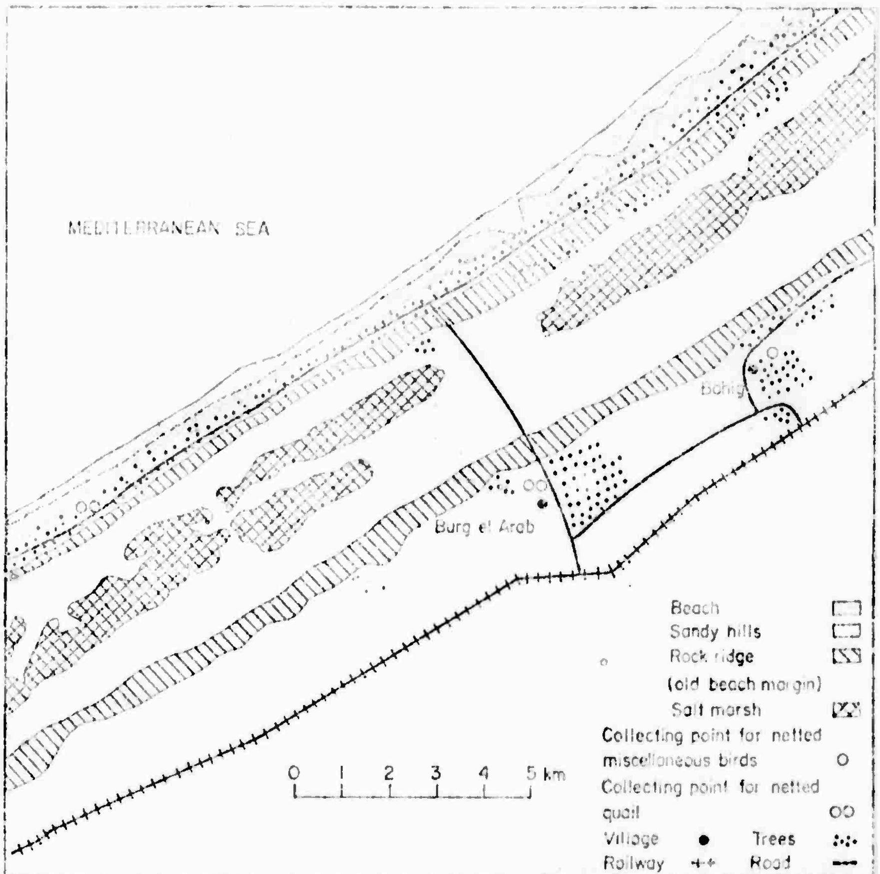

Figure 1. Cross-section of typical Mediterranean coast near Bahig - Burg El Arab collecting area.

Figure 2. Fig groves and Bedouin tents viewed from north near Bahig.

Figure 3. Olive and almond trees and gardens at Bahig.

Figure 4. Typical sandy desert west of the Nile.

Figure 5. Quail traps under fig trees. Dunes in left background mark southern limit of beach.

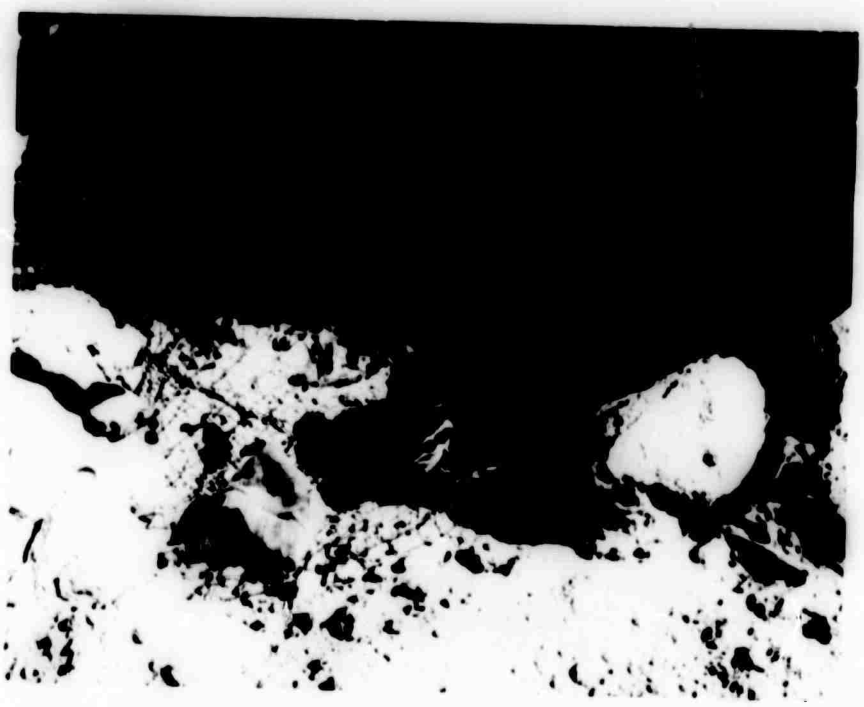

Figure 6. A trapped quail.

prices. Smaller passerine species were captured in tree nets (Figure 7), crop or clap traps with or without decoys, (Figure 8), and with bird lime (Figure 9). Waders were captured in nets set in water (Figure 10). Some of the Bedouins operated PMS mistnets set up in their gardens. The birds were brought to a central collecting facility or villa in the same or nearby village where they were catalogued, weighed, measured, examined for ectoparasites and either banded and released or set aside for shipment to the NAMRU-3 laboratory in Cairo. Birds that were banded were insofar as possible, aged and sexed on plumage and skull characters, marked with an aluminum band bearing the return addresses, ZOO CAIRO UAR or GIZA ZOO CAIRO EGYPT, and released in a secluded garden where they hopefully avoided immediate recapture. Birds intended for use as anatomical or blood specimens were caged by species and sent by truck to Cairo three times weekly. In Cairo, the live birds were bled from the heart or jugular into a heparinized syringe (since spring 1968) without antibiotic; the blood was centrifuged and the supernatant was pipetted off and saved deep frozen at -55 to -70°C; since spring 1969 the cell residue has also been frozen. During the first two years, blood from several specimens of the same species of smaller birds was pooled, but in later work individual blood samples were kept separate.

Ticks and other ectoparasites were collected after routine examination. A portion was stored in alcohol for identification and taxonomic study at NAMRU-3, while the remainder was identified and deep frozen for virus isolation.

Figure 7. A tree net in Bahig.

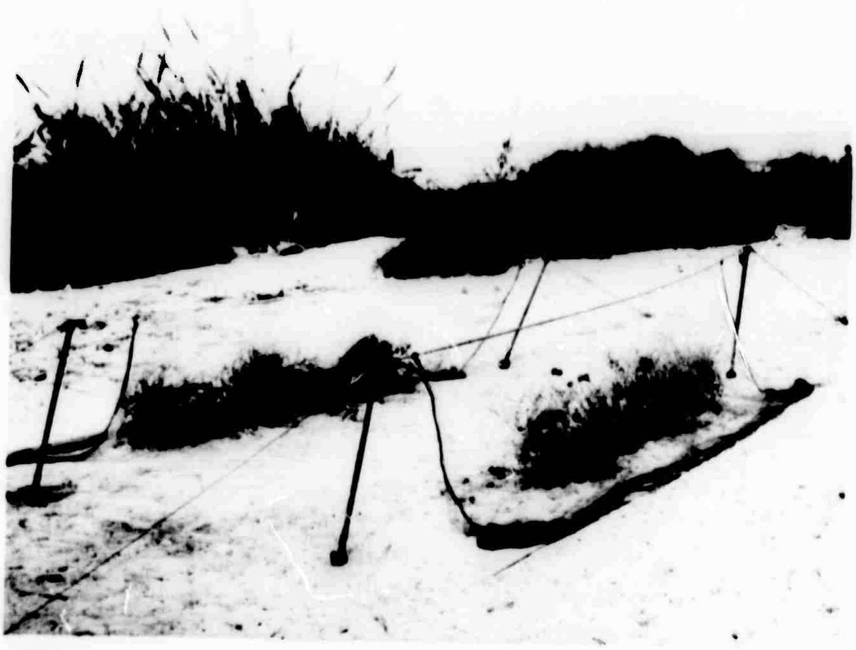

Figure 8. A finch trap with a live decoy on the beach.

Figure 9. A female Wheatear, *Oenanthe oenanthe*, trapped by birdlime.

Figure 10. A shorebird net set near Port Said.

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MOREAU, R. E. 1961. Problems of Mediterranean - Saharan migration. Ibis 103a: 373-427, 580-623.

MOREAU, R. E. and R. M. DOLP. 1970. Fat, water, weights and wing-lengths of autumn migrants in transit on the northwest coast of Egypt. Ibis 112: 209-228.

Banding

Bird banding began in Egypt in 1937 under the auspices of the Giza Zoological Gardens near Cairo and the Zoological Society of Egypt. During the early years, special emphasis was placed on banding ducks, quail, wagtails and finches. From 1937 to 1939 and in 1941, approximately 3500 birds were banded per year; in 1940, 1942 and 1943, lesser numbers were banded. Operations were suspended during 1944-1946, but banding resumed on a reduced scale in 1947 and continued at least until 1951 (Table 1). All records of this first phase of banding up to 1951 are kept in serial ledgers at the Zoological Gardens. Correspondence on recoveries in the Zoo offices suggests that some banding continued after 1951, but banding records cannot be found in the ledgers. Early recoveries of Egyptian banded birds found in Egypt and elsewhere, and of foreign banded birds found in Egypt, were reported by Mackintosh (1941). Banding activity from Spring 1949 to Fall 1950, when Heligoland traps produced many passerines at Fayid, was discussed by Brownlow (1952). The relatively high rates of recovery of Egyptian bands in quail and ducks, reported by Mackintosh, was largely due to their being game species and therefore more likely to come into human hands than would passerines. A total of 20,252 birds of 64 species were ringed during this first period.

Until 1966 no further banding was carried on but apparently surplus bands were placed on Zoo birds in the Giza Gardens. In the late fall of that year, operations using CAIRO ZOO UAR or GIZA ZOO CAIRO EGYPT return

TABLE 1

Birds Banded in Egypt, 1937-1951

Species	1937-1943	1947-1948	1949-1951
Acanthis cannabina	400	-	-
Accipter nisus	-	-	1
Acrocephalus schoenobanus	-	-	12
" scirpaceus	-	-	5
Anas acuta	4220	211	98
" clypeata	1544	23	-
" crecca	1593	114	51
" penelope	566	-	-
" platyrhynchos	219	20	12
Anthus trivialis	-	-	27
Ardea cinerea	2	-	-
Calandrella cinerea	298	-	-
Carduelis carduelis	133	-	-
" spinus	497	-	-
Cercotrichas galactotes	-	-	6
Charadrius alexandrinus	1	-	-
Chloris chloris	776	-	-
Coturnix coturnix	4523	-	3
Cuculus canorus	-	-	1
Cyanosylvia svecica	1	-	-
Emberiza caesia	406	-	-
" calandra	9	-	-
" hortulanc.	70	-	-
Falco tinnunculus	-	-	1
Ficedula albicollis	-	-	30
" species	-	-	29
Fringilla coelebs	377	-	-
Hippolais icterina	-	-	2
" pallida	-	-	25
Ixobrychus minutus	-	-	1
Jynx torquilla	7	-	27
Lanius collurio	-	-	11
Lanius nubicus	-	-	12
Lanius senator	-	-	3
Larus genei	31	-	-
" fuscus	1	-	-
Luscinia megarhynchos	97	-	46
Monticola saxatilis	-	-	2
" solitarius	-	-	4
Motacilla alba	2249	-	3
Muscicapa striata	1	-	29
Oenanthe hispanica	-	-	4
" oenanthe	-	-	3
Oriolus oriolus	-	-	1

TABLE 1

Species	1937-1943	1947-1948	1949-1951
Passer hispaniolensis	52	-	20
Pelecanus onocrotalus	1	-	-
Phenicopterus ruber	40	-	-
Phoenicurus phoenicurus	49	-	130
Phylloscopus collybita	4	-	110
" *sibilatrix*	-	-	6
" *trochilus*	-	-	40
Prinia gracilis	1	-	-
Saxicola rubetra	-	-	3
" *torquata*	-	-	4
Serinus serinus	169	-	-
Sterna albifrons	12	-	-
Sturnus vulgaris	270	-	-
Sylvia atricapilla	-	-	7
" *borin*	-	-	66
" *cantillans*	3	-	4
" *communis*	177	-	64
" *curruca*	7	-	162
" *melanocephala*	-	-	1
" *rueppelli*	5	-	5
Upupa epops	-	-	2
	18,811	368	1,073

address bands were resumed by the Smithsonian PMS team, working through NAMRU-3 in collaboration with the Giza Zoological Gardens. A main banding station, during spring, was maintained at Bahig with some birds, especially quail, being captured in Burg El Arab. Some birds were also captured at Port Said, at Abu Rawash near Cairo, and in the Fayum. The capture methods of the Bedouins ensured that the birds were largely passerines and quail, but a scattering of smaller non-passerines was taken. The spring season, 1967, was quite successful but operations ceased for 15 months in June when hostilities forced evacuation. Renewed operations at Bahig in the fall of 1968 were curtailed because all birds had to be transported by truck back to NAMRU-3 in Cairo before banding and release. In spring of 1969, full operation was restored with American and Egyptian personnel in the field. In fall 1969, it was possible to operate a second banding station at Mersa Matruh. A total of 47,324 birds of 75 species were banded in the six seasons in Egypt by the PMS Program. The totals for each species handled (includes both birds banded and those used only for laboratory purposes) in Egypt and are shown in the Appendix II.

In addition to banding birds, the field team recovered many foreign bands and some of its own bands that Bedouins brought to the stations. These data are presented in Appendix I, pages 157 to 192, while recoveries of PMS bands are summarized in Table 2.

Although notes were published in the official European banding journal, The Ring, the recovery rate has not been impressive (Table 2). It was hoped it would be possible to stimulate interest in Egypt and in Europe by sending out circulars in many languages. The hostilities and

TABLE 2

Recoveries of PMS Birds

SPECIES	# BIRDS	BANDED	RECOVERED
Falco naumanni	1	Egypt	Lebanon
Coturnix coturnix	12	Egypt	Bulgaria
" "	2	Egypt	U.S.S.R.
" "	4	Egypt	Syria
" "	6	Egypt	Egypt
" "	4	Egypt	Lebanon
" "	1	Egypt	Turkey
" "	1	Egypt	Italy
Streptopelia turtur	1	Egypt	Egypt
Otus scops	1	Egypt	Egypt
Caprimulgus europaeus	1	Egypt	Egypt
Apus pallidus	1	Egypt	Egypt
Galerida cristata	1	Egypt	Egypt
Calandrella cinerea	1	Egypt	Egypt
Sylvia curruca	2	Egypt	Egypt
" "	1	Egypt	Bulgaria
Phylloscopus trochilus	1	Egypt	Finland
Muscicapa striata	1	Egypt	Greece
Oenanthe oenanthe	1	Egypt	Egypt
" *hispanica*	2	Egypt	Egypt
Phoenicurus ochruros	1	Egypt	Egypt
" *phoenicurus*	1	Egypt	Egypt
" "	1	Egypt	Lybia
Luscinia megarhynchos	1	Egypt	Egypt

Table 2 (Cont'd.)

Recoveries of PMS Birds

SPECIES	# BIRDS	BANDED	RECOVERED
Turdus philomelos	1	Egypt	Egypt
Ficedula sp.	1	Egypt	Egypt
" "	1	Egypt	Italy
Passer hispaniolensis	1	Egypt	Greece
Oriolus oriolus	1	Egypt	Lebanon
" "	1	Egypt	Egypt

subsequent restrictions made this publicity campaign impossible. Nevertheless, recovery information continues to come in slowly to the Zoo and the banding information is funnelled through the Smithsonian in Washington, D. C.

As is usual with reporting foreign recoveries, however, there is still a large backlog of foreign bands for which we have not yet received banding information. These are also listed in Appendix I, pages 223-231.

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BROWNLOW, H. G. 1952. A ringing station in Egypt. Ibis 94:128-132.

MACKINTOSH, D. R. 1941. Bird ringing recoveries. Zool. Soc. Egypt. Bull. 3:7-29.

Band Recovery Trips

In order to collect bands and make the project better known, band recovery trips were made to various parts of Egypt. These trips paid richly, not only in bands recovered, but also in information acquired and publicity generated. We have greatly enhanced our knowledge of bird-capture methods and accumulated a significant collection of bird traps at the same time. In travelling from village to village in quest of bands, the band recovery team impressed upon the many farmers, hunters, fishermen and shopkeepers encountered, the scientific value of bands and the importance of saving them. These casual meetings and discussions yielded much fascinating bird lore: local bird names; the dates of passage for species from village to village; migration flyways through a region. The bands recovered represent a significant contribution to the body of Egyptian recovery data. It must be remembered, however, that in many cases the recovery dates will be approximations. Concepts of time vary from culture to culture and the system used efficiently by an Egyptian farmer to mark the events of his life may not correspond to scientific reckoning. On these trips, the Field Team made observations on the ecological relationship of birds and men in Egypt. Aspects of this relationship, such as the importance of birds to man as a source of food and income, estimates of the number of wild birds taken, and the impact of man's trapping activities on migrating flocks, were further explored.

Zagazig: 16-19 December, 1969

The town of Zagazig (30.35 N, 31.31 E) is located about 85 km NE of Cairo on the main road to the coast. The band recovery team visited six villages in the governorate, in addition to Zagazig, learning that pigeon and quail are hunted for local consumption, but not for market. We recovered no bands, but a local official agreed to publish an article on band recoveries in the governorate newspaper.

Lake Manzala: 19-21 December, 1969

Lake Manzala (31.08 N, 31.56 E), a great shallow coastal lake, lies parallel with the Mediterranean coast, between the Nile at Damietta and the Suez Canal. This trip covered the towns and villages of Damietta, Gheit El-Nasara, Shata, El Manzala, El Matariya, Gammabia, El Rahmna, Ras el Barr, and Port Said in the environs of the lake. Four bands were recovered and a number of the many bird hunters and bird merchants promised to hold their bands in the future, instead of discarding them.

Lake Burullus: 8-12 January, 1970

Lake Burullus (31.30 N, 30.50 E), the second largest of the coastal lakes, lies between Damietta and Rosetta. The villages of Biyala, Baltim, Sidi Salem and Rosetta were visited. Baltim proved to be an important source of new information. Many migrants come through this area, and it was learned that various methods - birdcalls, decoys, nets, date-palm snares, limesticks - are used to attract and capture them. No bands were collected, but the groundwork for future recovery work was well laid. The City Council of Baltim tentatively granted permission for a future trip to the islands on Lake Burullus where bird-hunting is an important business.

New Nubia: 6-9 February, 1970

The band recovery team on this trip, visited nearly all the New Nubian villages. The original villages of ancient Nubia now lie under the waters of Lake Nasser, and since the emigrations of 1964-65, the people have relocated their towns north of Aswan. In these villages 66 foreign bands were recovered - sixty from birds shot in Old Nubia, six from New Nubia. Each of the villages - Tushka, Kalabsha, El Umbarakab, Dihmit, and Kom Ombo City (24.28 N, 32.57 E) was visited at least twice. Nubians regard bands as having magical properties, wearing them as amulets and putting great store by them. Our team at times was forced to purchase bands strung around someone's neck.

Alexandria Market: Frequent intervals.

Whenever members of the field team returned to Alexandria, they visited the Alexandria bird market to look for bands and to note any exotic species. Many bands were recovered in this fashion, but the circumstances of capture, especially locality, are quite imprecise.

Cyprus Field Operation

After hostilities forced evacuation of PMS personnel from Egypt in June 1967, it was decided to set up a temporary bird banding headquarters in Cyprus. We had reports that the local bird banders (mostly British military and diplomatic personnel on temporary assignment) were having difficulties with support from the British Trust for Ornithology, and would welcome outside assistance. Reality was quite the opposite. When it was rumored that the PMS wanted to band in Cyprus, the BTO that had sponsored local banding through the Cyprus Ornithological Society since 1957, at first threatened to stop all British banding, but later welcomed our offer to use their bands.

Strict rules were laid down for PMS banders in the fall of 1967 in Cyprus. We were only to band on British Soverign bases, which meant the Akrotiri Peninsula in south central Cyprus, and were to be under the local direction of the Cyprus Ornithological Society. The main purpose behind this arrangement was so as not to introduce the Cypriote bird catchers, who take more than a million migrants annually using birdlime, to the "modern" methods of using mistnets. It was feared this would increase the take of migrants beyond sustainable yield.

A five-man team stayed in Cyprus for about three months in the fall of 1967 and although it added considerably to the numbers of birds banded in that country, its results were disappointing. In addition, it was impossible to run laboratory blood collection on the small numbers of birds captured due to conservation restrictions imposed by the British members of COS.

For the spring of 1968, however, the PMS secured permission from the Cyprus government and British Military Hospital in Dekhelia to purchase birds from the birdlimers in Paralimni in southeast Cyprus, and to carry out laboratory processing of bloods at the hospital. This provided adequate blood samples for a live virus and serological survey, but did not increase the number of birds banded nor improve public relations with the British Trust for Ornithology.

The village of Paralimni is about 250 feet above sealevel and one mile inland. It lies on the northern end of a peninsula culminating at Cape Grew ten miles to the south. The terrain is level or gently rolling. Cultivated fields, citrus and other orchards surround the village and on eastern coastal fringe but on rocky portions of the western side of the peninsula, xeric adapted forks, low Mediterranean scrub, and juniper woodland occur. Most of the birdliming took place on the lowlying coastal strip east and south of the village.

The favored locations for liming were small groves near open fields or sources of fresh water. The lime-sticks, which are coated with a sticky mixture of honey and the crushed pulp of the Assyrian Plum, were placed in trees and bushes favored by birds. When a bird alit on the lime-stick, it was held tight by the coating. The birds were brought live to a central collecting center in Paralimni where they were sorted, identified and weighed. Those in the best condition (2337 individuals of 49 species) were banded and released; those in less good condition (9419 individuals, 50 species) were released unbanded; a portion (2939 of 88 species) were bled or prepared as specimens; while a larger portion

(10,506 of 79 species) died and were discarded. The total number of birds handled was 25,201. Their distribution by species and day is listed in Appendix II.

During the 64 liming days, between March 5 and May 11, 1968, the limers of Paralimni brought an average of nearly 394 birds per day to the PMS. The most frequently caught species, *Sylvia curruca* (5415), *Phylloscopus collybita* (4646) and *Sylvia atricapilla* (3946), account for more than 55% of the total examined. Also taken in large numbers were *Phoenicurus phoenicurus* (1325), *Sylvia hortensis* (1062), *Sylvia communis* (676), *Phylloscopus trochilus* (673), *Ficedula hypoleuca* and *F. albicollis* (568) and *Sylvia cancantillans* (654). Sixteen other species were represented by samples of 100 to 400 birds. These 29 species constituted over 94% of the total examined. The species most vulnerable to lime catching were small to medium sized species that skulk or perch in trees and bushes.

Of the 2337 birds banded, so far 11 have been recovered in Cyprus again or elsewhere (summarized in Table 3 and details in Appendix I maps, pages 1-137 and lists, pages 157-192). Bands from 8 other national programs (England, Sweden, Czechoslovakia, Germany, USSR, Jordan, Israel and Nigeria) were recovered. These recoveries are also shown on the maps in Appendix I, pages 1-137 and detailed on pages 157-192.

Birds intended for the blood survey were transported to the British Military Hospital at Dekhelia where they were bled from the heart or jugular. The blood samples were centrifuged and stored deep frozen until they could be shipped to YARU. The results of YARU's analysis of these serum samples is included in the virus section of this report.

Table 3

Recoveries of PMS Birds

SPECIES	# BIRDS	BANDED	RECOVERED
Calidris alba	1	Cyprus	Tunisia
Streptopelia turtur	1	Cyprus	U.S.S.R.
Caprimulgus europaeus	1	Cyprus	Tanzania
Upupa epops	1	Cyprus	Cyprus
Motacilla alba	1	Cyprus	Czechoslovakia
Sylvia hortensis	1	Cyprus	Lebanon
" *atricapilla*	2	Cyprus	Lebanon
" *curruca*	1	Cyprus	Italy
Luscinia megarhynchos	1	Cyprus	Israel
Carduelis chloris	2	Cyprus	Cyprus

Uganda Field Operation, Fall 1968

Work in Egypt and Cyprus demonstrated that migrating birds can transport arbovirus between continents. In an attempt to follow the migrants farther south to their winter quarters, a PMS field team consisting of the Hubbards and an Egyptian assistant, went to the East African Virus Research Institute in Entebbe, Uganda for three weeks in October 1968 to conduct serological and ectoparasite survey of the Palearctic migrants in the area.

From October 4 through October 25 birds were netted daily from sunrise to sundown on Lunyo Estate, on the outskirts of Entebbe. The netting area was a 25 acre tract of cut-over tropical evergreen forest. Most of the larger trees had been removed, but a pproximately ten per cent of the area was still covered with trees 30 to 60 feet high. The rest of the forest was dense second-growth up to 30 feet high. The Lunyo forest is bordered by a grass and papyrus marsh on one side, pastureland on two others sides, and forest on the fourth. From 10 to 35 nets were used and checked every half hour. Birds were examined twice daily. Those not needed for laboratory work were identified, aged, sexed, examined for ticks, marked by wing clipping, and released. Other birds were taken to the Virus Research Institute for bleeding and specimen preparation.

In three weeks of netting, 627 birds of 78 species (another 16 species were observed in the area) were captured. Of these, 248 birds of 44 species were bled. This included 114 weavers and their allies (15 species), and 120 Palearctic migrants and related African warblers, flycatchers, and thrushes (24 species). Only 46 Palearctic migrants of 6 species were captured and bled. (9 *Muscicapa striata*, 2 *Phylloscopus trochilus*, 1 *Hippolais icterina*, 33 *Sylvia borin*, 1 *Acrocephalus scirpaceus* and 1 *Lanius collurio*). All birds were negative for ticks.

The small number of migrant warblers - flycatchers and thrushes - captured was probably due to the diffusion of migrants in tropical Africa in contrast to their concentration in the vegetated parts of northern Egypt on passage. Other migrants, such as wagtails, swallows and shore-birds, were not rare, but could not be captured. Attempts to isolate live virus from the blood samples were negative.

Bird Specimen Collections

During the PMS, specimens of several sorts have been collected. Primary emphasis has been placed on good representation of skins of migrants and when possible resident birds for systematic studies. The main purpose in collecting the migrants has been to identify the subspecies of birds passing through northeast Africa, and thereby attempt to deduce the breeding or wintering area of the birds. In this way it may be possible to predict foci of virus activity by monitoring migrants. It has been necessary to collect large numbers of specimens throughout the migratory season in order to determine whether different subspecies pass at different times. Some of the subspecies are well marked and relatively discrete while others vary gradually in west to east clines of decreasing color, and north to south clines of decreasing size. For a large proportion of the species migrating through Egypt and Cyprus, birds from a broad range of the Palearctic represented by several subspecies are involved. The general provenance of the birds found in the eastern Mediterranean on passage is given on the distribution maps in Appendix I (pages 1-137).

Sufficient skins have now been collected in Egypt to carry out systematic studies on the migrants. These include 2045 skins collected during the PMS, plus specimens collected by earlier NAMRU-3 studies in the area and now deposited in the Chicago Natural History Museum (1879 specimens), and Smithsonian Institution (174 specimens).

In addition, 532 specimens were collected in Cyprus in 1967-1968. Other important collections of specimens from the Palearctic are available for comparison in the American Museum of Natural History in New York and the Yale Peabody Museum in New Haven, Connecticut.

Systematic studies on the migrants have begun but are not yet completed. One of the more complex groups in the Palearctic, and one that is represented by many migrant species in the eastern Mediterranean, is the Old World Warbler subfamily Sylviinae. A majority of the virus isolations made during the PMS have been from warblers, particularly from the genus *Sylvia*. The principal investigator is reviewing the subfamily for Peters' *Checklist of Birds of the World*, and has completed a manuscript on the Western Palearctic species. Work is also in progress on a checklist of the birds of Egypt, and we are providing information to the editors of *The Birds of the Western Palearctic*.

A large number of specimens, both skeletons (2200+) and alcoholics (2400) from the eastern Mediterranean, have been added to the Smithsonian collections for anatomical study. The alcoholic specimens may also be used for food habit and to a lesser extent for systematic studies.

Ticks

Data on the ticks collected during six migration seasons in Egypt and two seasons in Cyprus have been compiled in Tables 1-11. These tables summarize ticks recovered from each species and demonstrate differential infestation loads and infestation rates between bird species. In Egypt, a total of 1276 birds yielded 2917 ticks while in Cyprus, 295 birds yielded 967 ticks. The breakdown by seasons and by year is as follows:

In Egypt in the fall of 1966 (Table 1), 129 birds comprising 27 species yielded 384 ticks of 5 species. The tick species were: *Hyalomma marginatum marginatum, Ixodes ricinus, I. arboricola, I. pari (=frontalis), Haemaphysalis punctata.* All bird species except 8 carried *Hyalomma m. marginatum.* Of those carrying *H. m. marginatum, Coturnix coturnix* carried two other tick species, as did *Luscinia luscinia, Phylloscopus collybita, P. trochilus, Turdus merula; Passer domesticus* and *Sylvia communis* each carried one. The three highest infestation loads were for *Sylvia borin* (8.0), *Passer domesticus* (6.3), *Turdus philomelos* (6.0). The five highest infestation rates (Table 7) for birds of which more than 50 were handled were *Passer domesticus* (47.0), *Carduelis carduelis* (22.0), *Luscinia luscinia* (11.0), *Coturnix coturnix* (9.0), *Phoenicurus phoenicurus* (7.0).

In Egypt, in the fall of 1968 (Table 2), 111 infested birds comprising 20 species yielded 253 ticks representing 6 species: *Hyalomma m. marginatum, Haemaphysalis punctata, Ixodes otophila, I. frontalis, I. redikorzevi* and *I. arboricola.* All bird species but 3 yielded *Hyalomma m. marginatum.* Of these *Luscinia megarhynchos, Phylloscopus collybita, P. trochilus* and *Sylvia borin* each yielded 2 other species; *C. coturnix, Erithacus rubecula, Lanius collurio, Sylvia atricapilla, Turdus philomelos* and *T. merula* yielded one other each. The 3 highest infestation loads were on *Cuculus canorus* (13.0), *Sylvia atricapilla* (4.5) and *Turdus philomelos* (4.1). The 4 highest infestation rates (Table 7) for birds of which more than 50 were handled were: *Luscinia luscinia* (28.0), *Turdus philomelos* (20.0), *Luscinia megarhynchos* (15.0), and *Lanius collurio* (9.0); another high rate of infestation was found in *Phoenicurus ochrurus* (36.0).

In Egypt, in the fall of 1969 (Table 3), 213 infested birds comprising 27 species yielded 522 ticks representing 4 species: *Hyalomma m. marginatum, Haemaphysalis punctata, Ixodes frontalis* and *I. ricinus*. All bird species but 5 yielded *Hyaloma m. marginatum*. Of these *Phylloscopus trochilus* and *Luscinia luscinia* yielded three other tick species; *Anthus trivialis, C. coturnix, Luscinia megarhynchos, Phoenicurus phoenicurus, Sylvia atricapilla, Turdus philomelos, T. merula* and *T. viscivorus* yielded one other tick species each. The 3 highest infestation loads were on *Cuculus canorus* (11.8), *Upupa epops* (5.0), and *Turdus merula* (4.3). The 3 highest infestation rates (Table 7) for birds of which more than 50 were handled were: *Phoenicurus phoenicurus* (6.0), *Luscinia luscinia* (5.0), and *Cuculus canorus* (4.0). *Anthus trivialis* (15.0) also showed a high rate of infestation.

In the spring of 1967 (Table 4), in Egypt, 158 birds comprising 22 species yielded 363 ticks of 6 species. Tick species were: *Hyalomma marginatum rufipes, Ixodes sp., I. arboricola, Amblyomma sp., Haemaphysalis hoodi, Ornithodoros sp.* All birds carried *H. m. rufipes* except *Passer domesticus*. *Anthus trivialis* carried 2 tick species in addition to *H. m. rufipes*; and *Luscinia megarhynchos*, one. The three highest infestation loads were *Caprimulgus europaeus* (31.0), *Jynx torquilla* (9.0), and

Oenanthe hispanica (6.0). The three highest infestation rates (Table 8) for birds of which more than 50 were handled were *Phoenicurus phoenicurus* (17.0), *Anthus trivialis* (10.0), and *Sylvia communis* (6.0); other high rates of infestation were found in *Passer domesticus* (70.0), *Falco tinnunculus* (30.0), *Oenanthe oenanthe* (18.0), and *Falco naumanni* (15.0).

In Egypt, in the spring of 1969 (Table 5), infested birds comprising 25 species yielded 271 ticks representing 5 species: *Hyalomma marginatum rufipes, Amblyomma variegatum, A. nuttalli, Ixodes euplecti,* and *Argas (Persicargas streptopelia.* All bird species but 2 yielded *Hyalomma marginatum rufipes.* Of these *Anthus trivialis* and *Oenanthe oenanthe* yielded two other species of ticks and *Hippolais icterina* and *Luscinia megarhynchos* each yielded one other species. The 34 highest infestation loads were on *Streptopelia turtur* (5.3), *Oenanthe oenanthe* (4.2), *Phylloscopus sibilatrix* (3.5), and *Carduelis chloris* (3.0). The 3 highest infestation rates (Table 8) for birds of which more than 50 were handled were: *Oenanthe oenanthe* (14.0), *Luscinia megarhynchos* (12.0) and *Oenanthe hispanica* (8.0). Another high infestation rate was found on *Oenanthe isabellina* (5.0).

In Egypt, in the spring of 1970 (Table 6), 508 infested birds comprising 34 species yielded 1124 ticks representing 9 species: *Hyalomma m. rufipes, Amblyomma variegatum, A. nuttalli, A. lepidum, Ripicephalus turanicus, Ixodes euplecti, I. arboricola, I. sp. nov.* and *Argas (Persiargas) streptopelia.* All bird species but 2 yielded *Hyalomma marginatum rufipes.* Of these *Anthus trivialis* yielded 4 other species, *Luscinia megarhynchos,* 2 other species, and *Hirundo rustica* and *Jynx torquilla* one other species each. The 4 highest infestation loads were on: *Streptopelia turtur* (12.0), *Turdus philomelos* (7.0), *Coturnix coturnix* (4.0) and *Hirundo rustica* ([illegible].0). The 4 highest infestation rates (Table 8) for birds of which more than 100 were handled were: *Oenanthe hispanica* (24.0), *Oenanthe oenanthe* and *Phoenicurus phoenicurus* (16) and *Upupa opops* (10.0). Another high rate of infestation was found on *Monticola saxatilis* (32.0).

In the fall of 1967 (Table 10), 118 birds from Cyprus comprising 30 species yielded 170 ticks representing 5 species: *Hyalomma m. marginatum*, *Haemaphysalis punctata*, *H. concinna*, *Ixodes frontalis* and *I. ricinus*. All bird species were infested with *H. m. marginatum*, *Phylloscopus trochilus* with 3 other tick species, *Erithacus rubecula* and *Turdus philomelos* each with 2, and *Carduelis chloris*, *L. luscinia*, *Motacilla flava*, *Muscicapa striata*, *Phylloscopus collybita*, *Saxicola torquata* and *Sylvia atricapilla* each with 1. The 3 highest records of infestation loads were for *Emberiza melanocephala* (7.0), *E. calandra* (3.0) and *Oenanthe finschii* (2.1).

The 3 highest infestation rates in Cyprus in the fall of 1967 (Table 11), for birds of which more than 100 were handled were *Erithacus rubecula* (12.6), *Carduelis chloris* (4.9) and *Phylloscopus trochilus* (4.7). Other high rates of infestation were *Oenanthe finschii* (78.3), *Turdus philomelos* (46.5) and *Saxicola torquata* (37.0).

In Cyprus, in the spring of 1968 (Table 9), 177 birds comprising 38 species yielded 797 ticks representing 8 species. Tick species were *Hyalomma marginatum rufipes*, *Amblyomma variegatum*, *A. nuttalli*, *A. lepidum*, *Ixodes ?tatei*, *I. frontalis*, *I. redikorzevi ?emberizae* and *Argas (Persicargas) streptopelia*. All bird species but 2 were infested with *H. marginatum rufipes*. Of these, *Anthus trivialis*, *Erithacus rubecula*, *Turdus philomelos* and *T. merula* yielded 2, 1, 1 and 4 other tick species, respectively. The 3 highest infestation loads were recorded for *T. philomelos* (12.3), *Streptopelia turtur* (7.5) and *Saxicola torquata* (6.7). The 3 highest infestation rates (Table 11), for birds of which more than 100 were handled were *Turdus philomelos* (16.8), *Otus scops* (6.4) and *Oenanthe oenanthe* (4.2). Other high rates of infestation were *Turdus merula* (100.0), *Monticola saxatilis* (45.5), *Galerida cristata* (25.5), *Falco tinnunculus* (21.2) and *Anthus trivialis* (18.6).

The percentage of *Hyalomma marginatum*, the most abundant tick species, was always lower on the fall migratory birds (as *H. m. marginatum*) than on the spring migratory birds (as *H. m. rufipes*). In Cyprus, these values were 81.1% in 1967, as compared to 95.0% in 1968. In Egypt, these values were 27.3% and 43.7% in 1968 and 1969, respectively, as compared to 80.7% and 94.1% in 1969 and 1970, respectively.

This project has yielded 2 new species, 1 has been described, *(Argas (Persicargas) streptopelia)*, (Kaiser, Hoogstraal and Horner, 1970), and the other is under description *(Ixodes* near *elongatus)*. *Amblyomma nuttalli*, *Ixodes tatei*, *I. euplecti* and *I. arboricola* are new records for migratory birds in Cyprus and Egypt. Distribution maps for the most frequently encountered tick species are shown in Appendix I, pages 138-148.

These tick data are still being worked on in Cairo by Dr. Kaiser who is currently relating them to habitat, behavior, and zoogeographic distribution of each bird species and in turn to the virus-carrying potential of each tick. This should permit him to draw conclusions on the epidemiological significance of the tick information.

Reference

KAISER, MAKRAM N., HARRY HOOGSTRAAL, and KENNETH O. HORNER. 1970. The subgenus *Persicargas* (Ixodoidea, Argasidae, *Argas*). 10. *A.* (*P.*) *streptopelia,* new species, widely distributed parasite of resident and migrating doves in Africa and Cyprus, and epidemiological consideration. Ann. Entomol. Soc. Amer., 63. 3: 799-807.

TABLE 1.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM FALL MIGRATORY BIRDS IN EGYPT, 1966

	H. marginatum marginatum			Other Tick Species					Total	
Bird Hosts	NN	LL	Ticks/ Bird	♂	♀♀	NN	LL	Species	No. of Birds	Ticks/ Bird
Acanthis cannabina	1		1.0						1	1.0
Anthus trivialis							3	*I. ricinus*		
							1	*I. arboricola*	2	2.0
Carduelis carduelis	12	3	1.0						15	1.0
Carduelis spinus					1			*I. pari* (=*frontalis*)	1	1.0
Chloris chloris	7	6	1.6						8	1.0
Coturnix coturnix	3	13	4.0			5		*Haemaphysalis punctata*	7	3.0
Crex crex							1	*H. punctata*	1	1.0
Lanius collurio	2		1.0						2	1.0
Luscinia luscinia	6	1	3.5				13	*I. ricinus*		
							2	*H. punctata*	9	2.4
Luscinia megarhynchos							1	*I. ricinus*	1	1.0
Motacilla flava		1	1.0						1	1.0
Muscicapa striata		3	1.0						3	1.0
Oriolus oriolus	1		1.0						1	1.0
Passer domesticus		8	4.0		4	54	155	*I. arboricola*	35	6.3

TABLE 1.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM FALL MIGRATORY BIRDS IN EGYPT, 1966 (con't.)

	H. marginatum marginatum			Other Tick Species					Total	
Bird Hosts	NN	LL	Ticks/ Bird	♂	♀♀	NN	LL	Species	No. of Birds	Ticks/ Bird
Passer hispaniolensis		1	1.0						1	1.0
Phoenicurus ochruros gibraltariensis		1	1.0						1	1.0
Phoenicurus phoenicurus	7	3	1.5						7	1.5
Phylloscopus collybita		2	1.0				1	*I. ricinus*		
						1	11	*I. pari* (=*frontalis*)	10	1.5
Phylloscopus trochilus	1	9	1.3				3	*I. ricinus*	12	1.2
						1		*H. punctata*		
Prunella modularis		2	2.0						1	2.0
Pycnonotus barbatus	1		1.0						1	1.0
Sylvia atricapilla						1		*I. ricinus*	1	1.0
Sylvia borin							8	*I. ricinus*	1	8.0
Sylvia communis		2	1.0				9	*I. pari* (=*frontalis*)	3	4.0
Turdus merula							1	*I. ricinus*		
					1	4		*I. arboricola*	2	3.0
Turdus philomelos							6	*I. pari* (=*frontalis*)	1	6.0
Upupa epops	1		1.0						1	1.0

TABLE 2.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM FALL MIGRATORY BIRDS IN EGYPT 1968

	H. marginatum marginatum			Other Tick Species					Total	
Bird Hosts	NN	LL	Ticks/ Bird	♂	♀♀	NN	LL	Species	No. of Birds	Ticks Bird
Coturnix coturnix				1	4	1		*I. redikorzevi*	2	3.0
Cuculus canorus		13	13.0						1	13.0
Erithacus rubecula		1	1.0			1	6	*I. frontalis*	5	1.6
Jynx torquilla		4	2.0						2	2.0
Lanius collurio	2	3	1.0			1		*H. otophila*	6	1.0
Luscinia luscinia	5	4	2.3				2	*H. punctata*		
						2	64	*I. frontalis*	23	3.3
Luscinia megarhynchos	3	3	1.2			1		*H. punctata*		
							6	*I. frontalis*	10	1.3
Muscicapa striata		4	1.3						3	1.3
Oriolus oriolus	5	1	1.2						5	1.2
Otus scops	1		1.0						1	1.0
Passer hispaniolensis		1	1.0						1	1.0
Phoenicurus phoenicurus	4	1	1.0						5	1.0
Phylloscopus collybita		2	1.0			2	23	*I. frontalis*		
						3		*I. arboricola*	20	1.5

TABLE 2.

Bird Hosts	*H. marginatum marginatum* NN	LL	Ticks/ Bird	Other Tick Species ♂	♀♀	NN	LL	Species	Total No. of Birds	Ticks/ Bird
Phylloscopus trochilus		5	1.7							
							1	*H. punctata*		
							1	*I. frontalis*	5	1.4
Sylvia atricapilla										
							18	*I. frontalis*	4	4.5
Sylvia borin	1		1.0							
							1	*H. punctata*		
							2	*I. frontalis*	3	1.3
Sylvia communis	1	1	1.0							
Sylvia curruca		1	1.0						2	1.0
Turdus philomelos	3		1.5						1	1.0
						1	38	*I. frontalis*	10	4.1
Turdus merula										
						2	3	*I. frontalis*	3	1.7

TABLE 3.

SMITHSONIAN INSTITUTITON - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM FALL MIGRATORY BIRDS IN EGYPT 1969

Bird Hosts	H. marginatum marginatum NN	LL	Ticks/ Bird	Other Tick Species ♂	♀♀	NN	LL	Species	Total No. of Birds	Ticks/ Birds
Anthus trivialis	1	1	1.0			1		H. punctata	3	1.0
Coturnix coturnix	5		1.7			2		H. punctata	5	1.4
Crex crex							1	H. punctata	1	1.0
Cuculus canorus		47	11.8						4	11.8
Erithacus rubecula							7	I. frontalis	4	1.8
Fringilla coelebs				1				I. frontalis	1	1.0
Hippolais icterina				1				I. frontalis	1	1.0
Hirundo rustica		1	1.0						1	1.0
Jynx torquilla		2	2.0						1	2.0
Lanius collurio		1	1.0						1	1.0
Luscinia luscinia	12	7	3.2			1	11	H. punctata		
						1		I. frontalis		
Luscinia megarhynchos		2	1.0			10	161	I. ricinus	69	2.94
Muscicapa striata		1	1.0			1	6	I. ricinus	4	2.5
									1	1.0

TABLE 3.

Bird Hosts	*H. marginatum marginatum* NN	LL	Ticks/ Bird	Other Tick Species ♂	♀♀	NN	LL	Species	Total No. of Birds	Ticks Bird
Oenanthe hispanica		1	1.0						1	1.0
Oriolus oriolus	5	1	1.0						6	1.0
Phoenicurus ochruros		1	1.0						1	1.0
Phoenicurus phoenicurus	47	18	1.4		1		5	*I. frontalis*	48	1.5
Phylloscopus collybita						1	11	*I. frontalis*	6	2.0
Phylloscopus trochilus	1	38	2.4			3	4	*H. punctata*		
						1	28	*I. frontalis*		
							13	*I. ricinus*	28	3.1
Sylvia atricapilla		1	1.0		1		1	*I. frontalis*	3	1.0
Sylvia communis	4	4	1.3						6	1.3
Sylvia curruca	2		2.0						1	2.0
Saxicola rubetra	2		1.0						2	1.0
Turdus philomelos	2	5	1.9			1	10	*I. frontalis*	8	2.3
Turdus merula	3	1	4.0			2	7	*I. ricinus*	3	4.3
Turdus viscivorus	2		2.0				1	*I. ricinus*	2	1.5
Upupa epops		10	5.0						2	5.0

TABLE 4.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM SPRING MIGRATORY BIRDS IN EGYPT, 1967

	H. marginatum rufipes			Other Tick Species					Total	
Bird Hosts	NN	LL	Ticks/ Bird	♂	♀♀	NN	LL	Species	No. of Birds	Ticks/ Bird
Anthus campestris	3		1.5						2	1.5
Anthus trivialis	2	7	2.3		1			Ixodes sp.		
						1		Amblyomma sp.	6	1.8
Calandrella cinerea	1		1.0						1	1.0
Caprimulgus europaeus	31		31.0						1	31.0
Cercotrichas galactotes	5	1	6.0						1	6.0
Falco naumanni	1	1	1.0						2	1.0
Falco tinnunculus	3		1.0						3	1.0
Jynx torquilla	9		9.0						1	9.0
Lanius senator	1		1.0						1	1.0
Luscinia megarhynchos	4	9	1.3			1		Haemaphysalis hoodi	11	1.3
Monticola saxatilis	2		2.0						1	2.0
Muscicapa striata		3	3.0						1	3.0
Oenanthe hispanica	1	11	6.0						2	6.0
Oenanthe oenanthe	14	8	3.7						6	3.7

TABLE 4.

Bird Hosts	H. marginatum rufipes NN	H. marginatum rufipes LL	H. marginatum rufipes Ticks/Bird	Other Tick Species ♂	Other Tick Species ♀♀	Other Tick Species NN	Other Tick Species LL	Other Tick Species Species	No of Birds	Ticks/Bird
Passer domesticus						1		*Ornithodoros sp.*		
					47	52	2	*Ixodes arboricola*	30	3.4
Phoenicurus phoenicurus	101	25							77	1.6
Phylloscopus bonelli	2		1.0						2	1.0
Phylloscopus sibilatrix	1		1.0						1	1.0
Sylvia communis	5	1	1.0						6	1.0
Turdus merula	3	1	4.0						1	4.0
Turdus philomelos	1		1.0						1	1.0
Upupa epops	1		1.0						1	1.0

TABLE 5.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM SPRING MIGRATORY BIRDS IN EGYPT, 1969

	H. marginatum rufipes			Other Tick Species					Total	
Bird Hosts	NN	LL	Ticks/ Bird	♂	♀♀	NN	LL	Species	No. of Birds	Ticks/ Bird
Acrocephalus palustris		1	1.0						1	1.0
Anthus campestris	3	1	2.0						2	2.0
Anthus trivialis	7	8	5.0			23	3	*A. nuttalli*		
					3			*I. euplecti*	27	1.7
Carduelis chloris	4	2	3.0						2	3.0
Cuculus canorus						1		*A. nuttalli*	1	1.0
Falco naumanni	4		2.0						2	2.0
Falco tinnunculus	5		1.3						4	1.3
Hippolais icterina		3	1.0			1		*A. nuttalli*	4	1.0
Lanius senator	4	5	1.3						7	1.3
Luscinia megarhynchos	4	9	.92			2		*A. nuttalli*	13	1.7
Motacilla alba	1		1.0						1	1.0
Muscicapa striata		3	1.0						3	1.0
Oenanthe hispanica	6	2	1.6						5	1.6
Oenanthe isabellina	1	1	1.0						2	1.0

TABLE 5.

(Cont'd.)

	H. marginatum rufipes			Other Tick Species					Total	
Bird Hosts	NN	LL	Ticks/ Bird	♂	♀♀	NN	LL	Species	No. of Birds	Ticks/ Bird
Oenanthe oenanthe	36	15	4.64			1		*A. variegatum*		
					3			*I. euplecti*	13	4.2
Otus scops	1	1	1.0						2	1.0
Phoenicurus phoenicurus	47	19	1.7						40	1.7
Phylloscopus bonelli		1	1.0						1	1.0
Phylloscopus sibilatrix	7		3.5						2	3.5
Streptopelia turtur							16	*A. (P.) streptopelia*	3	5.3
Sylvia borin		1	1.0						1	1.0
Sylvia cantillans	2		1.0						2	1.0
Sylvia communis	3	9							10	1.2
Sylvia curruca	1		1.0						1	1.0
Sylvia ruepelli		1	1.0						1	1.0

TABLE 6.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM SPRING MIGRATORY BIRDS IN EGYPT, 1970

	H. marginatum rufipes			Other Tick Species					Total	
Bird Hosts	NN	LL	Ticks/ Birds	♂	♀♀	NN	LL	Species	No. of Birds	Ticks/ Birds
Acanthis cannabina	1		1.0						1	1.0
Acrocephalus schoenobaenus		2	1.0						2	1.0
Acrocephalus scirpaceus	3	1	1.3						3	1.3
Anthus campestris	5	5	2.0						5	2.0
Anthus trivialis	3	3	1.5			16		*A. nuttalli*	22	1.1
						2		*A. variegatum*		
						1		*A. lepidum*		
					1			*I. euplecti*		
Calandrella cinerea		4	1.0						4	1.0
Coturnix coturnix	8		4.0						2	4.0
Erithacus rubecula						2		*I. euplecti*	1	2.C
Ficedula sp.		1	1.0						1	1.0
Ficedula albicollis		1	1.0						1	1.0
Hippolais icterina	1	1	2.0						1	2.0
Hirundo rustica						4		*I. arboricola*	1	4.0

TABLE 6.

Bird Hosts	*H. marginatum rufipes* NN	*H. marginatum rufipes* LL	*H. marginatum rufipes* Ticks/Birds	Other Tick Species ♂	Other Tick Species ♀♀	Other Tick Species NN	Other Tick Species LL	Other Tick Species Species	Total No. of Birds	Total Ticks Birds
Jynx torquilla		11	3.7	1				*R. turanicus*	4	3.0
Lanius senator	25	4	2.6						11	2.6
Luscinia megarhynchos		4	1.0				2?	*A. nuttalli*		
					1			*I. sp. nov. near elongatus*	7	1.0
Monticola saxatilis	13	6	1.7						11	1.7
Monticola solitarius	1		1.0						1	1.0
Motacilla flava	4		1.0						4	1.0
Muscicapa striata		1	1.0						1	1.0
Oenanthe hispanica	41	63	2.2						48	2.2
Oenanthe isabellina	7	8	2.5						6	2.5
Oenanthe oenanthe	164	197	3.3						113	3.3
Otus scops	1	3	2.0						2	2.0
Phoenicurus phoenicurus	210	120	1.9						175	1.9
Phylloscopus bonelli	2	4	1.5						4	1.5
Phylloscopus collybita		1	1.0						1	1.0
Phylloscopus trochilus		1	1.0						1	1.0
Saxicola rubetra	2	3	1.7						3	1.7

TABLE 6.

Bird Hosts	*H. marginatum rufipes* NN	*H. marginatum rufipes* LL	*H. marginatum rufipes* Ticks/Bird	Other Tick Species ♂	Other Tick Species ♀♀	Other Tick Species NN	Other Tick Species LL	Other Tick Species Species	Total No. of Birds	Total Ticks/Bird
Streptopelia turtur		1	1.0				35	*A.* (P.) *streptopelia*	3	12.0
Sylvia atricapilla	2		2.0						1	2.0
Sylvia borin	4	1	2.0						2	2.0
Sylvia cantillans		2	1.0						2	1.0
Sylvia communis	37	29	1.6						41	1.6
Sylvia curruca	2	1	1.0						3	1.0
Sylvia rueppelli	6	1	2.3						3	2.3
Turdus philomelos	7		7.0						1	7.0
Upupa epops	11	20	1.3						23	1.3

TABLE 7.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICK INFESTATION RATES OF FALL CAPTURED BIRDS - EGYPT

	1966			1968			1969			Total		
	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate
Acanthis cannabina	1	1	100 %			%			%	45	1	2 %
Anthus trivialis	18	2	11	3			20	3	15	41	5	12
Carduelis carduelis	67	15	22				3			70	15	21
Carduelis spinus	36	1	3				1			37	1	2
Carduelis chloris	8	8	100				1			9	8	88
Coturnix coturnix	75	7	9	41	2	5	4314	5	.1	4433	14	.3
Crex crex	35	1	3	16			12	1	8	63	2	3
Cuculus canorus	10	1	10	11			92	4	4	113	5	.4
Erithacus rubecula	28			7	5	71	288	4	1	316	9	3
Fringilla coelebs							8	1	13	8	1	13
Hippolais icterina				26			135	1	< 1			< 1
Hirundo rustica				4			104	1	< 1	108	1	< 1
Jynx torquilla	16			16	2	13	77	1	1	109	3	3
Lanius collurio	165	2	1	64	6	9	1599	1	< .1	1832	9	< 1
Luscinia luscinia	84	9	11	81	23	28	1431	69	5	1596	101	6
Luscinia megarhynchos	32	1	3	67	10	15	294	4	1	393	16	4
Motacilla flava	6	1	17	2						8	1	13
Muscicapa striata	99	3	3	78	3	4	983	1	.1	1160	7	< 1

TABLE 7.

TICK INFESTATION RATES OF FALL CAPTURED BIRDS - EGYPT (Cont'd.)

Species	1966			1968			1969			Total		
	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate
<u>Oenanthe hispanica</u>	9		%	1		%	13	1	8 %	23	1	4 %
<u>Oriolus oriolus</u>	92	1	1	54	5	9	916	6	< 1	1084	12	1
<u>Otus scops</u>	3			10	1	10	16			29	1	4
<u>Passer domesticus</u>	74	35	47	133			13			220	35	16
<u>Passer hispaniolensis</u>	40	1	3	32	1	3	51			123	2	2
<u>Phoenicurus ochruros</u>	3	1	33	14	5	36	30	1	3	47	2	4
<u>Phoenicurus phoenicurus</u>	101	7	7	72			770	48	6	959	60	6
<u>Phylloscopus collybita</u>	263	10	4	636	20	3	1063	6	< 1	1965	35	2
<u>Phylloscopus trochilus</u>	263	12	5	721	5	< 1	3152	28	< 1	4136	45	1
<u>Prunella modularis</u>	6	1	17							6	1	17
<u>Pycnonotus barbatus</u>	5	1	20							5	1	20
<u>Saxicola rubetra</u>	10			10			31	2	7	51	2	4
<u>Sylvia atricapilla</u>	63	1	2	83	4	5	171	3	2	317	8	3
<u>Sylvia borin</u>	71	1	2	52	3	6	360			483	4	1
<u>Sylvia communis</u>	88	3	3	61	2	2	1310	6	< 1	1465	11	< 1
<u>Sylvia curruca</u>	112			60	1	2	1528	1	< .1	1738	2	.1
<u>Turdus merula</u>	2	2	100	7	3	43	116	3	3	123	8	7
<u>Turdus philomelos</u>	10	1	10	52	10	20	238	8	3	302	19	6

TABLE 7.

TICK INFESTATION RATES OF FALL CAPTURED BIRDS - EGYPT (Cont'd.)

Species	1966			1968			1969			Total		
	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate
Turdus viscivorus			%			%	4	2	50 %	4	2	50 %
Upupa epops	30	1	3	2			39	2	5	72	3	4

TABLE 8.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICK INFESTATION RATES OF SPRING CAPTURED BIRDS - EGYPT

	1967			1969			1970			Total		
	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate
Acanthis cannabina	1	1	100 %			%	18			19	1	5 %
Acrocephalus palustris	14	--		48	1	3	2			64	1	2
Acrocephalus schoenobaenus	31			56			114	2	2	201	2	1
Acrocephalus scirpaceus	29			14			359	3	< 1	402	3	1
Anthus campestris	2	2	100	15	2	13	125	5	4	140	9	6
Anthus trivialis	63	6	10	1063	27	2	572	22	4	1698	55	3
Calandrella cinerea	62	1	2	258			1014	4	.4	1334	5	.4
Caprimulgus europaeus	4	1	25	13			37			54	1	2
Carduelis chloris	1			2	2	100	11			14	2	14
Cercotrichas galactotes	1	1	100							1	1	100
Coturnix coturnix	19			21			69	2	3	109	2	2
Cuculus canorus	15			34	1	3	12			61	1	2
Erithacus rubecula	19			39			33	1	3	91	1	1
Falco naumanni	19	2	15	16	2	13	4			39	4	10
Falco tinnunculus	10	3	30	11	4	37	3			24	7	29
Ficedula sp.	312			368			157	1	< 1	837	1	.1
Ficedula albicollis	92			157			120	1	< 1	369	1	.3

TABLE 8.

TICK INFESTATION RATES FOR SPRING CAPTURED BIRDS - EGYPT (Cont'd)

Species	1967			1969			1970			Total		
	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate
Hippolais icterina	11		%	129	4	3 %	42	1	2 %	182	5	3 %
Hirundo rustica	27			152			174	1	< 1	353	1	.3
Jynx torquilla	50	1	2	9			272	4	2	331	5	2
Lanius senator	22	1	5	115	7	6	260	11	4	397	19	5
Luscinia megarhynchos	69	11	2	112	13	12	744	7	< 1	925	31	3
Monticola saxatilis	10	1	10	16			34	11	32	60	12	20
Monticola solitarius	1			4			2	1	50	8	1	13
Motacilla alba	7			124	1	< 1	38			169	1	< 1
Motacilla flava				2			112	4	4	116	4	3
Muscicapa striata	94	1	1	395	3	< 1	226	1	.4	715	5	< 1
Oenanthe hispanica	38	2	5	67	5	8	204	48	24	309	55	12
Oenanthe isabellina	6			22	2	9	196	6	3	224	8	4
Oenanthe oenanthe	33	6	18	91	13	14	537	113	21	661	132	20
Otus scops	29			44	2	5	50	2	4	123	4	3
Passer domesticus	39	30	77	49			15			103	30	29
Phoenicurus phoenicurus	458	77	17	967	40	4	1069	175	16	2494	292	12
Phylloscopus bonelli	164	2	1	157	1	< 1	154	4	3	475	7	1
Phylloscopus collybita	115			21			182	1	< 1	318	1	.3
Phylloscopus sibilitrix	330	1	.3	450	2	.4	62			842	3	.4

TABLE 8.

TICK INFESTATION RATES FOR SPRING CAPTURED BIRDS - EGYPT (Cont'd.)

Species	1967 # Birds Handled	1967 # Birds Infested	1967 Infest. Rate	1969 # Birds Handled	1969 # Birds Infested	1969 Infest. Rate	1970 # Birds Handled	1970 # Birds Infested	1970 Infest. Rate	Total # Birds Handled	Total # Birds Infested	Total Infest. Rate
Phylloscopus trochilus	10		%	45		%	53	1	2 %	105	1	1 %
Saxicola rubetra	5			29			63	3	5	97	3	3
Streptopelia turtur		3			3		33			53	6	11
Sylvia atricapilla	67			69			54	1	2	142	1	< 1
Sylvia borin	37			405	1	.3	457		.4	899	3	.3
Sylvia cantillans	216			256	2	< 1	372	2	< 1	843	4	< 1
Sylvia communis	97	6	6	1018	10	< 1	664	41	6	1779	57	3
Sylvia curruca	133			347	1	.3	158	3	2	639	4	< 1
Sylvia rueppelli	58			196	1	< 1	154	3	2	408	4	1
Turdus merula	5	1	20				9			14	1	7
Turdus philomelos	27	1	4	9			68	1	2	104	2	2
Upupa epops	41	1	2	92			232	23	10	368	24	7

TABLE 9.

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM FALL MIGRATORY BIRDS IN CYPRUS, 1967

Bird Hosts	*H. marginatum marginatum* NN	LL	Ticks/ Bird	Other Tick Species ♀♀	NN	LL	Species	Total No. of Birds	Ticks/ Bird
Acrocephalus arundinaceus		1	1.0					1	1.0
Acrocephalus palustris	2		1.0					2	1.0
Anthus spinoletta		1	1.0					1	1.0
Anthus trivialis	1	1	1.0					2	1.0
Carduelis chloris	6	2	1.0	2			*I. frontalis*	10	1.0
Emberiza calandra		3	3.0					1	3.0
Emberiza melanocephala	6	1	7.0					1	7.0
Erithacus rubecula	9		1.9		1	4	*I. frontalis*	11	1.5
					1	1	*I. ricinus*		
Fringilla coelebs	1	1	1.0					2	1.0
Galerida cristata	1	2	1.5					2	1.5
Jynx torquilla		2	2.0					1	2.0
Luscinia luscinia		1	1.0			3	*I. ricinus*	3	1.3
Motacilla alba	9	4	1.6					8	1.6
Motacilla flava	1	2	1.0		1		*I. frontalis*	4	1.0

TABLE 9.

(Con't.)

Bird Hosts	*H. marginatum marginatum* NN	LL	Ticks/ Bird	Other Tick Species ♀♀	NN	LL	Species	Total No. of Birds	Ticks/ Bird
Muscicapa striata		2	2.0			1	*H. punctata*	2	1.5
Oenanthe finschii	1	22	2.1					11	2.1
Otus scops	5	2	1.8					4	1.8
Passer hispaniolensis		1	1.0					1	1.0
Phoenicurus ochruros	1		1.0					1	1.0
Phoenicurus phoenicurus	5		1.3					4	1.3
Phylloscopus collybita		2	1.0			2	*I. frontalis*	4	1.0
Phylloscopus trochilus		13	1.3			1	*I. frontalis*		
						3	*H. punctata*		
Phylloscopus trochilus						1	*H. concinna*	14	1.3
Saxicola rubetra	5		1.7					3	1.7
Saxicola torquata	5	6	1.2	1			*I. frontalis*	10	1.2
Sylvia atricapilla	1		1.0			2	*I. frontalis*	2	1.5
Sylvia curruca		1	1.0					1	1.0
Streptopelia turtur		2	2.0					1	2.0
Turdus merula	1		1.0					1	1.0
Turdus philomelos	2	1	1.0	2	2	3	*I. frontalis*		

TABLE 9.

(Con't.)

Bird Hosts	*H. marginatum marginatum*			Other Tick Species				Total	
	NN	LL	Ticks/ Bird	♀♀	NN	LL	Species	No. of Birds	Ticks/ Bird
Turdus philomelos					1		*I. ricinus*	7	1.6
Tyto alba	2	1	1.0					3	1.0

TABLE 10

SMITHSONIAN INSTITUTION - NAMRU-3 PALEARCTIC MIGRATORY BIRD SURVEY

TICKS FROM SPRING MIGRATORY BIRDS IN CYPRUS, 1968

Bird Hosts	*H. marginatum rufipes* NN	LL	Ticks/ Bird	♂	♀♀	Other Tick Specis NN	LL	Species	Total No. of Birds	Ticks/ Bird
Anthus cervinus	2	1	1.5						2	1.5
Anthus trivialis	7	2	1.3			1		*I. ?tatei*		
						1		*A. variegatum*	9	1.2
Carduelis carduelis	1		1.0						1	1.0
Carduelis chloris	1		1.0						1	1.0
Cuculus canorus	1		1.0						1	1.0
Emberiza caesia		1	1.0						1	1.0
Emberiza calandra		3	1.0						1	1.0
Erithacus rubecula	8		4.0			1		*I. frontalis*	3	3.0
Falco tinnunculus	28	8	5.1						7	5.1
Ficedula albicollis	1		1.0						1	1.0
Fringilla coelebs	1		1.0						1	1.0
Galerida cristata	3	4	2.3						3	2.3
Hippolais pallida		2	1.0						2	1.0

TABLE 10.
(Con't.)

Bird Hosts	*H. marginatum rufipes* NN	LL	Ticks/ Bird	Other Tick Species ♂	♀♀	NN	LL	Species	Total No. of Birds	Ticks/ Bird
Sylvia curruca	4	1	1.7						3	1.7
Sylvia hortensis		2	1.0						2	1.0
Sylvia melanothorax	5		2.5						2	2.5
Sylvia nisoria	1		1.0						1	1.0
Turdus philomelos	347	156	12.6		1			*I. redikorzevi ?emberizae*	41	12.3
Turdus merula	6	2	2.7			1		*A. lepidum*		
						1		*I. ?tatei*		
						1		*I. frontalis*		
				1	1			*I. redikorzevi ?emberizae*	7	1.9
Upupa epops	1		1.0						1	1.0

TABLE 10

(Con't.)

Bird Hosts	*H. marginatum rufipes* NN	*H. marginatum rufipes* LL	*H. marginatum rufipes* Ticks/Bird	Other Tick Species ♂	Other Tick Species ♀♀	Other Tick Species NN	Other Tick Species LL	Other Tick Species Species	Total No. of Birds	Total Ticks/Bird
Lanius collurio	16	2	3.0						6	3.0
Luscinia megarhynchos	2		1.0						2	1.0
Luscinia luscinia						1		*A. nuttalli*	1	1.0
Monticola saxatilis	9	1	2.0						5	2.0
Monticola colitarius		2	1.0						1	1.0
Oenanthe hispanica	2	4	2.0						3	2.0
Oenanthe isabellina	5		1.7						3	1.7
Oenanthe oenanthe	4	2	k,2						5	1.2
Oenanthe pleschanka	23	14	2.1						18	2.1
Otus scops	16	2	2.6						7	2.6
Phoenicurus phoenicurus	13	2	1.3						12	1.1
Phylloscopus collybita		1	1.0						1	1.0
Phylloscopus trochilis	1		1.0						1	1.0
Saxicola torquata	17	3	6.7						3	6.7
Streptopelia turtur							30	*A. (P.) streptopelia*	4	7.5
Sylvia atricapilla	12	2	1.1						13	1.1
Sylvia communis	3		1.5						2	1.5

TABLE 11

SMITHSONIAN INSTITUTION - NAMRU-3 - PALEARCTIC MIGRATORY BIRD SURVEY
TICK INFESTATION RATES OF BIRDS - CYPRUS

	Fall 1967			Spring 1968		
	# Birds Handled	# Birds Infested	Infest Rate	# Birds Handled	# Birds Infested	Infest Rate
Acrocephalus arundinaceus	14	1	7.2			
Acrocephalus palustris	24	2	8.3			
Anthus cervinus				15	2	13.2
Anthus spinoletta	5	1	20.0			
Anthus trivialis	6	3	33.0	43	8	18.6
Carduelis carduelis				54	1	1.8
Carduelis chloris	205	10	4.9	2	1	50
Cuculus canorus				58	1	1.7
Emberiza caesia				41	1	2.4
Emberiza calandra	2	1	50.0			
Emberiza melanocephala	2	1	50.0			
Erithacus rubecula	138	11	12.6	373	3	.8
Falco tinnunculus				33	7	21.2
Ficedula albicollis				187	1	.5
Fringilla coelebs	7	2	28.5	3	1	33.0
Galerida cristata	22	2	9.1	13	3	25.5
Hippolais pallida				37	2	5.4

TABLE 11

	Fall 1967			Spring 1968		
	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate
Jynx torquilla	3	1	33.0			
Lanius collurio				467	6	1.5
Luscinia megarhynchos				112	2	1.8
Luscinia luscinia	17	3	17.6	95	1	1.1
Monticola saxatilis				11	5	45.5
Monticola solitarius				18	1	5.6
Motacilla alba	187	8	4.3			
Motacilla flava	210	4	1.9			
Muscicapa striata	42	2	4.8			
Oenanthe finschii	14	11	78.3			
Oenanthe hispanica				94	3	3.2
Oenanthe isabellina				166	5	3.0
Oenanthe oenanthe				481	18	4.2
Oenanthe pleschanka				284	7	2.5
Otus scops	4	4	100.0	109	7	6.4
Passer hispaniolensis	35	1	2.9			
Phoenicurus ochrurus	7	1	14.2			

TABLE 11

	Fall 1967			Spring 1968		
	# Birds Handled	# Birds Infested	Infest. Rate	# Birds Handled	# Birds Infested	Infest. Rate
Phoenicurus phoenicurus	58	4	7.8	1165	12	1.0
Phylloscopus collybita	41	4	9.8	3606	1	.03
Phylloscopus trochilus	295	14	4.7	673	1	.15
Saxicola rubetra	7	3	43.0			
Saxicola troquata	27	10	37.0	75	3	4.0
Streptopelia turtur	14	1	7.2	4	4	100.0
Sylvia atricapilla	255	2	.8	3946	13	.3
Sylvia communis				676	2	.3
Sylvia curruca	20	1	5.0	5372	3	.05
Sylvia hortensis				1031	2	.2
Sylvia melanothorax				101	2	2.0
Sylvia nisoria				51	1	2.0
Turdus merula	1	1	100.0	7	7	100.0
Turdus philomelos	15	7	46.5	244	41	16.8
Tyto alba	3	3	100.0			
Upupa epops				335	1	0.3

Arbovirus Isolation and Serological Survey
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Introduction

The initial attempts to isolate arboviruses from old-world migrating birds were by Schmidt (unpublished) working at NAMRU-3 near Cairo in the fall of 1961 and 1962. The NAMRU-3 team recovered numerous viruses from the blood of birds migrating from Eurasia to Africa. These agents when compared among themselves were found to represent at least 6 serotypes which were sent to YARU for further identification (see Table 13). The 6 types included Kemerovo, Uukuniemi, Matruh of the Tete group (representing over 50 isolates), 2 new interrelated viruses, Burg el Arab and Matariya and a sixth unnamed virus, also apparently new to science.

Very few other studies involving migrating birds have been reported. Nir *et al* (1967) isolated West Nile and Sindbis viruses from turtle doves in Israel; Takahashi *et al* (in press) found Japanese encephalitis virus in a warbler, *Phylloscopus borealis*, presumably migrating to Japan prior to the usual Japanese encephalitis season; and Bond *et al* (in press) reported isolation of eastern equine encephalitis from two Black and White Warblers, *Mniotilta varia*, in Florida.

The present report includes results of virus isolation attempts from 3,890 individual and pooled blood samples collected in Egypt and Cyprus from 6,152 birds between 1966 and 1969. Pertinent serological identification data on the viruses isolated as well as on selected other bird viruses referred to YARU for identification are included. In addition, extensive hemagglutination inhibition (HI) tests with arboviruses were carried out with samples from the fall migration of 1966 in Egypt and from the spring migration of 1968 in Cyprus, and isolation of virus was attempted from pools of ticks taken from migratory birds.

Techniques

Bird sera (fall 1966-spring 1968, many of them pooled by species), plasmas (spring 1968, again often pooled), and erythrocytes (fall 1968-fall 1969, not pooled) were received at YARU frozen and stored at -70°C or colder until inoculated intracerebrally (i.c.) into 1-4 day-old Swiss mice of YARU Charles River stock, 6 mice per sample. Brains of mice sick or dead during a 2-week observation period were sub-passaged as 10% suspension until a passage line was established. Reisolation was attempted in many cases.

Characterization of infectious agents included serological comparison with mouse pathogens (mostly arboviruses) in the YARU-WHO Internationl Reference Centre for Arboviruses collection, and in the cases of some of the new viruses, filtration through gradacol membranes, deoxycholate sensitivity, and infection of, and transmission by *Aedes aegypti* mosquitoes of the YARU colony. Details of the identification procedures as used at YARU are described by Shope (1970).

Ticks were pooled, limiting the pools to individuals of the same tick species and host species, with 25 ticks or less per pool. They were triturated in 2.0 ml. amounts of phosphate buffered, 0.75% bovine albumin containing antibiotics, centrifuged and the supernatant inoculated into mice as above.

Serological tests were carried out on bird sera and plasmas stored at -70°C until processing. For HI tests the techniques of Clarke and Casals (1958) were used with acetone extraction of sera and plasmas and a micro technique in leucite plates. The sera were screened at a 1:10 dilution and those positive were titered. HI tests of the 1966 sera were done with antigens of group A (Middelburg, Sindbis, Semliki Forest, Y-62-33, chikungunya, Ndumu), group B (Entebbe bat, yellow fever, Wesselsbron, Israel turkey meningo-encephalitis, Zika, Ntaya, louping ill, West Nile) and also Tahyna and Bunyamwera.

HI tests of the 1968 plasmas included antigens of chikungunya, Sindbis, West Nile, Wesselsbron, yellow fever, Bunyamwera, Tahyna, Ingwavuma, Bahig, and Matruh.

Neutralization tests were in baby mice i.c. using undiluted plasma or serum incubated 1 hour at 37°C with decimal dilutions of virus and then inoculated. Mice were observed usually for 2 weeks and end-points calculated by the Reed-Muench formula.

For serological identification of isolates neutraliztion, HI, and complement-fixation (CF) tests were employed.

Results

Viruses isolated from birds. Viruses were isolated from migrating birds during both migration seasons of each year of this project. A total of 3,890 pools or individual samples representing 6,152 bloods were processed from 1966 through 1968. From these were isolated 54 mouse pathogenic agents. These are presumably viruses, although not all are completely characterized. Table 1 lists the viruses, their hosts, the dates of isolation, and results of re-isolation where attempted. Tables 2-8 list the bird species tested for virus isolation by season, year, and site of capture.

In addition to the 3,890 samples above, 641 individual erythrocyte specimens collected during the fall of 1969 were inoculated into mice with all but 14 negative. Passages from these 14 bloods are frozen waiting definitive characterization. They include the following birds: Jynx torquilla (7985, 7990, 8011, 8292), Sylvia communis (8127, 8302), Sylvia curruca (8003, 8017), Caprimulgus europaeus (7986), Muscicapa striata (8029), Sylvia borin (80481), Phoenicurus phoenicurus (8056), Lanius minor (8293), and Oenanthe oenanthe (9516).

Forty-two agents belong to the Tete group of viruses, closely related to Matruh (An 1047-61) isolated from a lesser Whitethroat Warbler, Sylvia curruca, in Egypt by Dr. Jack Schmidt at NAMRU-3 in 1961 and more distantly related to Tete (An 3518) isolated from a Spotted-backed Weaver, Ploceus spilonotus, in South Africa in 1959.

Over half of the Tete group isolates have come from the warbler genus Sylvia. All but two, those from the Swallow, Hirundo rustica, and the Song Thrush, Turdus philomelos, were recovered from fall migrants. This virus complex has been prevalent each fall since 1966. The infection rate was remarkably high in some species. For instance, of 54 Common Whitethroat Warblers, Sylvia communis, captured in 1968, five (9.3%) were viremic with this complex.

Strain Eg B 90, Bahig, from a Golden Oriole, Oriolus oriolus, was selected for further characterization. Complete details are given in Table 23 as the data were submitted for registration in the Catalogue of Arthropod-borne Viruses.

The virus passed a 0.22 micron filter but not a 0.1 micron filter. It was inactivated 5.4 log LD_{50} by sodium deoxycholate. A sucrose acetone extracted, sonicated brain antigen hemagglutinated goose red blood cells at pH 5.9.

Bahig virus killed baby mice inoculated i.c. and titered 5.4 log LD_{50} . It had a similar titer in VERO cell culture in which it produced pathogenic granulation and rounding-up of cells.

Bahig virus was closely related by CF test to Matruh virus and more distantly to Tete virus. By HI test it was easily distinguished from Matruh. Bahig immune ascitic fluid did not react in CF test with 117 arbovirus antigens, or herpes, LCM, rabies, vaccinia, and Newcastle disease virus. HI tests showed cross-reaction of Bahig virus with immune ascitic fluids of Simbu, Ingwavuma, Manzanilla, Mermet, Buttonwillow, Bwamba, California, and Bunyamwera viruses at the levels of 1:10 and 1:20. These viruses are all members of the Bunyamwera supergroup of arboviruses. Bahig virus did not react by HI test with 64 other arboviruses. This is interpreted as evidence that Bahig virus pertains to the Bunyamwera supergroup of arboviruses.

Colonized Aedes aegypti were inoculated intra-thoracically with 10% mouse brain infected with Bahig virus. Virus was demonstrated in the mosquito salivary glands 21 days later and 2 further serial passages in Aedes aegypti of infected salivary glands were successful. Infected Aedes aegypti have been induced to take blood meals from baby mice, but these attempts have been unsuccessful in transmission of virus.

Other isolates shown in Table 1 include E 890-3, closely related to the new Simbu group virus Thimiri, from a pool of four Lesser Whitethroat Warblers heading south on fall migration through Egypt; E 241 (probably not an arbovirus) from a Red-backed Shrike, Lanius collurio, in Egypt in fall, C 40, E 3505, and E 3127, three related agents from a variety of spring and fall migrants from Cyprus and Egypt, which are not yet fully characterized; Ingwavuma, twice isolated from northward migrating Spotted Flycatchers, Muscicapa striata, in Cyprus in spring; O 3255, related to Eg An 4996-63 isolated by Dr. Schmidt in Egypt during 1963, both viruses from viremic Turtle Doves, Streptopelia turtur, in Cyprus in spring; and West Nile virus from the Barred Warbler, Sylvia nisoria, also in Cyprus in spring.

Serological results. HI tests with 16 arbovirus antigens were done on 868 sera collected in Egypt during the fall of 1966. While most were migratory, a few were from indigenous water birds of the Nile delta. The antigens included 6 group A viruses (Middelburg, Sindbis, Semliki, Y-62-33, chikungunya, Ndumu), 8 group B viruses (Entebbe bat, yellow fever, Wesselsbron, Israel turkey Meningoencephalitis, Zika, Ntaya, louping ill, West Nile), and Tahyna and Bunyamwera.

None of the migratory birds reacted with 4 antigen units in the 1:20 dilution.

All of the HI test positives were in Egyptian resident birds (Tables 2-4). Fifteen Gallinula chloropus and 2 Fulica atra inhibited either or both Sindbis and Y-62-33. Titers were generally higher to Sindbis. These are aquatic rails of North Egypt.

Fifteen sera reacted with group B viruses including yellow fever, Wesselsbron, Israel turkey, Zika, Ntaya, and West Nile. Ten of these were from F. atra, 3 from G. chloropus, and 1 each from Tyto alba (owl) and Bubulcus ibis. It was not possible in most cases to distinguish which group B virus was responsible for the HI reactions. The 3 G. chloropus sera reacted specifically in the 1:20 dilution with yellow fever virus. Overall, 12/24 F. atra and 18/70 G. chloropus sera were positive.

Neutralization tests of 117 sera of birds of the 1966 fall migration using 100 LD_{50} of Bahig virus were negative. These sera were from Falco (5), Upupa (5), Oriolus (45), Coturnix (4), Lanius (40), Cuculus (1), Jynx (3), Acrocephalus (2), Sylvia (11), and Muscicapa (1).

One thousand, thirty-six individual or pooled plasmas from migratory birds collected in Cyprus during the spring 1968 migration were tested for HI antibody to 10 arboviruses (chikungunya, Sindbis, West Nile, Wesselsbron, yellow fever, Bunyamwera, Tahyna, Ingwavuma, EgB90, and EgAn1047-61). Table 7 lists the plasmas collected, by bird species.* Positive HI reactions were found with Sindbis (group A), West Nile (group B), Ingwavuma (group Simbu), and with both Bahig and Matruh.

Sindbis. Sindbis HI antibody (Table 9) was found in Coracias garrulus (1), Jynx torquilla (1), Upupa epops (1), Lanius collurio (2), Sylvia communis (1),

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*One plasma was not tested, hence the difference in total numbers tested and collected.

Sylvia curruca (1), Sylvia hortensis (1), Monticola saxatilis (1), Phoenicurus phoenicurus (1), and Luscinia megarhynchos (1). All of these plasmas also neutralized Sindbis virus except Sylvia curruca (negative) and Sylvia hortensis (not tested). Ten control plasmas, of corresponding species where possible, were both HI and neutralization negative.

West Nile. Group B HI antibody (Table 10) was found in Streptopelia turtur (8), Otus scops (1), Upupa epops (2), Falco tinnunculus (7), Emberiza calandra (1), Emberiza melanocephala (1), Oriolus oriolus (2), Lanius nubicus (2), Lanius collurio (1), Lanius minor (1), Phylloscopus collybita (1), Phylloscopus trochilus (1), Phylloscopus bonelli (1), Acrocephalus arundinaceus (2), Sylvia communis (2), Sylvia rüppelli (1), Sylvia curruca (3), Sylvia atricapilla (1), Sylvia nisoria (6), Sylvia hortensis (2), Monticola saxatilis (2), Turdus philomelos (1), Oenanthe oenanthe (1), Oenanthe pleschanka (1), Oenanthe isabellina (2), Erithacus rubecula (1), and Anthus trivialis (1).

The majority of the HI positive reactions were higher in titer with West Nile antigen than with other group B viruses. Since West Nile virus was isolated from Sylvia nisoria, it appears most likely that West Nile infection was responsible for the observed group B HI antibody. Neutralization tests with West Nile also indicated correlation between HI positivity and increased survival time of mice; complete neutralization of approximately 100 LD_{50} occurred in 17 of 48 of the above plasmas; prolonged survival time occurred in another 22. An equal number of control HI negative plasmas were tested, only 6 of which had neutralization or prolonged survival time. Four of these 6 were from the Roller family.

The possibility of one or more group B viruses other than West Nile being responsible for some of the observed group B HI reactions must be considered.

Ingwavuma. Ingwavuma HI antibody (Table 11) was limited to the following passerines : Emberiza caesia (1), Oriolus oriolus (2), Sylvia melanothorax (1), Sylvia borin (2), and Sylvia hortensis (2). Five of these plasmas in a neutralization test demonstrated complete protection or significant prolongation of survival time when compared to comparable HI negative control plasmas.

Tete group. HI results for Bahig (EgB90) and Matruh (EgAn1047-61) are presented together (Table 12) since several individuals reacted with both of these related viruses and the evidence presented here indicates that these are two members of a group of viruses and that perhaps some of the antibody is to other viruses of the group as yet not characterized.

Positive reactions were seen with Falco tinnunculus (1), Emberiza hortulana (2), Emberiza caesia (1), Emberiza calandra (1), Phylloscopus trochilus (1), Sylvia communis (1), Sylvia curruca (4), Sylvia nisoria (14), Sylvia borin (4), Sylvia hortensis (1), Turdus philomelos (1), Erithacus rubecula (1), Luscinia megarhynchos (2). The predominance in the genus Sylvia is evident.

All but 3 of these HI reactive plasmas were tested by neutralization test with Bahig or Matruh viruses using HI negative plasmas of corresponding species (where available) as controls. Fifteen of 31 test plasmas had prolonged average survival time (over 5 days) whereas only 2 of 31 controls showed comparable prolongation. Complete protection was rare but correlated with high HI titer. Either the HI test is more sensitive than the neutralization test or the HI reactions represent heterologous antibody. It is doubtful that the HI reactions could be nonspecific in view of the genus (Sylvia) specificity and the correlation between HI antibody and demonstrated natural viremia in this genus.

Negative isolation , tempts from tick pools. Ticks from 424 birds were inoculated in baby mice as 221 pools. No pathogens were established from these ticks.

Serological identification of YARU isolates and bird viruses referred from other laboratories. At the inception of the program it soon became apparent that it would be necessary to identify respectable numbers of isolates and that reference strains of bird viruses must be stocked. Some of these were in the YARU collection but many more were solicited and received from seven laboratories involved in isolation of viruses from birds: University of Ibadan (UI), Nigeria; Naval Medical Research Unit-3 (NAMRU-3), Cairo; South African Medical Research Institute (SAMRI), Johannesburg; the Vellore and Poona Laboratories, India; the Institute of Poliomyelitis Research, Moscow, USSR; the Cali Virus Laboratory, Columbia; and the Belem Virus Laboratory (BVL), Brazil. A list of selected viruses from birds now in the YARU collection is shown in Table 13. In order to properly identify the YARU isolates it was necessary to study in depth the antigenic characteristics of many of these referred viruses of birds.

Bahig. This virus of the Tete group was partially described in a previous section. A listing of negative CF and HI results is given in Tables 14 and 15. Results of attempts to type 9 Tete group viruses isolated in 1968 using neutralization testing are shown in Table 16.

Thimiri. This virus isolated from blood of _Sylvia curruca_ reacted by CF with the Simbu grouping ascitic fluid and not with 16 other grouping ascitic fluids. A serum Thimiri (EgB890-3) with homologous titer of 1:1024reacted 1:16 with Buttonwillow, 1:32 with Oropouche and 1:8 with Simbu antigens and was negative with 6 others indicating that the relationship by CF to the Simbu group viruses was definite but not very close to any of the previously described members. Thimiri represents a newly-recognized member of the Simbu group.

Neutralization tests comparing 3 strains of Thimiri virus indicate that the EgB890-3 strain may differ slightly from the 1963 Egypt and India isolates (Table 17).

E 241. This isolate from Lanius collurio is not sensitive to sodium deoxycholate and is therefore probably not an arbovirus. Further characterization has not been carried out to date.

E 3127 group. CF tests indicate that C40, C45, and C125-6 agents are very closely related, that E3235-7 and E3505 are also very close, and that these with E3127 form a group (Table 18). Infectivity of the agents for mice is of a low order and not well preserved by lyophilization. No cross-reactions of this group have been noted with Bahig, Thimiri and E241 but extensive serological study has not been undertaken.

Q3255. This virus from Streptopelia turtur passed a 0.22μ filter and was sensitive to sodium deoxycholate although the low infective titer did not allow quantitation. It was closely related by CF to EgAn4996-63 also isolated from Streptopelia turtur in 1963 by Schmidt. Q3255 antigen cross-reacted with Quaranfil immune ascitic fluid, however, the observation has not been consistently repeatable and further work is indicated to confirm the relationship.

Q3488-9. HI and neutralization tests showed this to be Ingwavuma virus as follows:

Antigens (HA)	Ingwavuma ascitic fluid	Q3488-9 ascitic fluid
Ingwavuma	1:160	1:160
Q3488-9	1:10	1:80
Virus		
Ingwavuma	3.0 LNI	3.5 LNI
Q3488-9	2.0 LNI	3.5 LNI

Ingwavuma ascitic fluid reacted less with Q3488-9 than homologous virus by both HI and neutralization test indicating Q3488-9 may be a variant strain.

Q3574-5. This strain of West Nile virus was referred to Dr. James W. Ryan, Department of Epidemiology, School of Hygiene and Public Health, The Johns Hopkins University, for determination of geographic sub-type by the grid HI test. Dr. Ryan reported: "For testing West Nile strains, I used individual chick antisera, screened for specificity, in the grid HI test overnight at 4°C with a final pH of 7.0. In this test anti-Cyprus serum did not give a complete identity reaction with any other strain but was only two-fold different from strains in Africa south of the Sahara, slightly more different from those of the Near East and definitely different from those of Pakistan, France, India, and Nigeria.

The most discriminatory southern African antiserum gave reactions of identity with the Cyprus isolate, as opposed to slight but definite differences with Near Eastern strains; and the most discriminatory Near Eastern antiserum gave slight but definite differences with the Cyprus and southern African isolates. From these results I would think that the Cyprus isolate was acquired from the region south of Egypt and probably south of the Sahara."

Serological study of EgAn1169- 61, An1825-61, An1477-61, An3782-62, and An1398-61 isolated by Dr. J. Schmidt of NAMRU-3.

EgAn1169-61. This virus was isolated in 1961 from *Phoenicurus phoenicurus*. It has been identified as Kemerovo virus (recovered in 1962 from *Ixodes persulcatus* and from febrile humans in Western-Siberia) on the basis of CF and neutralization tests (Table 19).

EgAn1825-61. This virus was isolated in 1961 from *Phylloscopus trochilus*. It has been identified as a new virus, related to Uukuniemi and Grand Arbaud. Uukuniemi was first recovered from *Ixodes ricinus* in 1959 in South western Finland and is believed to involve *Ixodes* and birds in its cycle. Ticks have also been implicated in the cycle of Grand Arbaud virus. Table 20 shows the relationships by CF of these viruses.

EgAn1477-61 and EgAn3782-62. These two viruses, isolated from *Sylvia curruca*, are related by CF (An1477-61 ascitic fluid with homologous titer of 1:128 reacts 1:4 with An3782-62; An3782-62 ascitic fluid with homologous titer of 1:512 reacts 1:128 with An1477-61). They, as well as EgAn1398-61 from *Coturnix coturnix*, have been tested with 81 specific and 16 grouping ascitic fluids of arboviruses and probably represent new, previously undescribed viruses (Table 21).

Serological study of Balagodu (I633970), I64434, and I66414 from India.

Balagodu (I633970) from the paddy bird (*Ardeola grayii*) has been identified on the basis of CF and HI tests as Ingwavuma using both the South African prototype virus and the Q3488-9 Ingwavuma strain isolated from Cyprus from a spring migrant. The existence of Ingwavuma virus in India greatly enlarges its geographic range and strengthens the hypothesis that migrating birds are responsible for its transport from one geographical area to another.

I64434 virus from *Ardea cinerea* has been identified by CF test as Nyamanini virus or a very close relative. Nyamanini is also known from Egypt and South Africa and has been previously isolated from cattle egrets and *Argas* ticks.

I66414 virus from *Ardeola grayii* has been identified by CF test as Thimiri virus (see above), in the Simbu group.

In addition, results of CF studies of BeAn141106, Cali-874, Conn An114, I66413, I66415, I66416, and IbAn28946 are shown in Table 22. These bird viruses remain ungrouped.

Discussion

Birds are essential to cycles of some arboviruses and other zoonotic agents. The birds may enter in virus cycles in two ways, 1) maintenance of viruses in endemic or epidemic local foci and 2) the transport of viruses over long distances through bird migration. The results of this study apply mainly to the latter.

Viruses were isolated from the blood of migrating birds on 54 occasions in Egypt and Cyprus indicating clearly the potential for transport of viruses by migratory birds. In no case is it clear that virus from a migrating bird became established in a host-vector cycle in a new geographical area. There is evidence for involvement ofpalearctic birds with at least seven viruses for which something is known of their world-wide distribution and epidemiology in endemic foci: West Nile, Sindbis, Ingwavuma, Kemerovo, Uukuniemi, Thimiri and the Tete group of viruses.

West Nile virus epidemiology has been extensively studied in Egypt (Taylor et al, 1956) where man is usually involved in early childhood with a mild febrile infection transmitted by mosquito bite. The virus cycle involves birds and the mosquito, *Culex univittatus*. Isolations from birds have been reported in South Africa, Egypt, Israel, Russia, Borneo, and Cyprus (Taylor, 1967). There are at least 3 different geographical subtypes. In the present study in Cyprus, West Nile of the sub-Saharan subtype was recovered from a northward migrating Barred Warbler, *Sylvia nisoria*, strongly suggesting that the warbler had been infected in its wintering grounds and had transported the virus over a long distance into Europe. This does not mean necessarily that introduction of West Nile led to its establishment in a new focus in Europe.

Human infections with Sindbis virus have been recorded in Uganda and South Africa, (Taylor, 1967); however, the virus itself has been recovered from many parts of Africa as well as Russia, India, Malaya, and Australia. Birds are believed to be the principal vertebrate hosts and Culex mosquitoes, the vector. Sindbis has been isolated from birds in Egypt, South Africa, and India. Antibody in northward migrating birds captured in Cyprus in 1968 indicates that these birds may have played a role in the enzootic epidemiology of the virus somewhere in sub-Saharan Africa. There is no evidence from this study that migrating birds actually transport Sindbis virus.

Ingwavuma has been isolated in India from a paddy bird and in Natal, South Africa from mosquitoes and from the Spectacled Weaver (Hyphanturgus ocularius). In Cyprus Ingwavuma was isolated from a Spotted Flycatcher (Muscicapa striata), Mercer (1969). The Spotted Flycatcher breeds in Europe and winters in southern Africa. The site of the South African isolations lie well within the range of the Spotted Flycatcher, suggesting that the Spotted Flycatcher may have transported the virus from an enzootic area in South Africa to Cyprus.

Kemerovo virus was first isolated from the blood of a migratory Redstart, Phoenicurus phoenicurus, in Egypt during 1961 and was subsequently recognized by Russian workers (Chumakov et al, 1963) as the probable cause of a febrile, non-paralytic tick-borne illness in Siberia. It cannot be categorically stated that the migrating Redstart was infected in Siberia and traveled to Egypt, although it is a possibility since large numbers of Redstarts nest in Siberia.

Uukuniemi is another tick-borne virus which is believed to involve birds in its enzootic cycle in Northern Europe. A related virus, EgAn1825-61 was isolated from the blood of Phylloscopus trochilus by Dr. Jack Schmidt in Egypt in 1963 during southward migration. Since there are no known foci of Uukuniemi-related viruses in Africa, it is assumed that the virus in southward migrants fails to become established. Nevertheless, this potential should be recognized.

Thimiri, a new Simbu group virus, has been isolated in Vellore, India and twice in southward migrating warblers in Egypt. The presence of viremic southward migrants suggests that there are enzootic foci in Eurasia (other than Vellore), as yet unrecognized. The significance of this virus as a cause of human disease in Europe or Asia is not known. A related new-world virus, Oropouche, has caused severe, wide-spread human febrile illness in Brazil.

The most frequently encountered viruses in the blood of palearctic migrants belong to the Tete group. At least two sero-types, Bahig (Watson et al, 1969) and Matruh are recognized. They are characteristically found in fall migrants, primarily in warblers, thrushes, and finches. In one species, Sylvia communis, in 1968, 9.3% of 54 birds tested were infected. This is a regular annual virus introduction into Africa as evidenced by the NAMRU-3 study in 1961 to 1963 and the present study 1966 to 1968.

The current working hypothesis is that the Bahig and Matruh viruses are enzootic somewhere in Europe. This hypothesis is strenthened by the isolation of 2 viruses of the Bahig complex from migrating Fringilla in Gorizia Province, Italy in November 1968 (Balducci, personal communication). The actual European enzootic focus is yet to be found, however. One might also hypothesize that infected birds would be predominately juveniles since adults might be immune. In actual experience during 1968 when individual (rather than pooled) specimens were examined, there was no significant difference between isolation rates from juveniles and adults. There was also no sex difference.

The 1968 isolates, typed by neutralization test, represented both Bahig and Matruh types (Table 16). On any given day, all of the isolates were of one type. This might be explained in at least 3 ways, 1) that there was cross-contamination in the laboratory during bleeding or isolation attempts-unlikely because of successful re-isolation from many samples and because samples were processed on different days in most cases, 2) that there was bird to bird transmission in Egypt either before capture or during transport to the laboratory - unlikely (but not disproven) because of the very short time elapsed between arrival in Egypt and bleeding, and 3) that birds captured in any given day represented arrivals from a given flock or flocks which originated or passed through a given enzootic focus. Implicit in this reasoning is that related but antigenically differing viruses occur in enzootic foci which are geographically or biologically separate.

Laboratory experiments, designed to determine if Bahig virus would multiply in and be transmitted by mosquitoes, demonstrated multiplication but not transmission. The actual mode of transmission in nature is not yet known. A possibility still to be considered is that of latency in the bird, with viremia provoked by the stress of migration. Latency would adequately explain the very high percentage of viremia in birds arriving in Egypt.

Hoogstraal et al (1961, 1963, 1964) have documented the abundance and variety of ticks on migrating palearctic birds. Infected ticks on migrating birds could readily transport viruses over long distances. Viruses were not isolated from ticks in the present study; however, the small number of ticks examined (221 pools from 424 birds) do not represent a sufficient sample to rule out ticks as a significant mechanism of virus transport.

To summarize, this and previous studies have demonstrated that migrating viremic birds carry arboviruses both north and south, and that these viruses represent a large variety of tick-borne and mosquito-borne agents. The evidence with at least one virus (West Nile) favors transport over a long distance from Africa to Cyprus. Evidence with other viruses (Tete group, Thimiri) favors transport by enormous numbers of warblers from Europe to Africa. The evidence is not sufficient to say that any of these viruses become established in viable cycles in their new ecosystems.

Some intriguing potential applications of these phenomena suggest themselves. If the origin of a viremic migrating bird could be firmly established by banding or sub-speciation data, the endemic focus of the virus could then be predicted. It might thus be possible to carry out surveillance of virus activity in countries otherwise closed to investigation for political or military reasons. For example, the finding of Kemerovo virus in blood of a migrating Redstart in 1961 in Egypt could have signalled the activity of this virus (actually demonstrated) in Siberia, a potential source of origin of the Redstart and the virus.

As a corollary to the preceding, if the geographic site of an endemic viral focus is known it should be possible to predict the origin of a viremic or antibody-carrying bird. This could reinforce banding data. Admittedly a great deal more scientific knowledge must be accumulated, both concerning endemic viral foci and concerning viruses and antibody in birds, before this application could be practical.

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Egypt and Cyprus Bird Isolates

Serum No.	Species	Date	Virus	Reisolation
E 90	Oriolus oriolus	2 Sept.66	Bahig	+
E 241	Lanius collurio	4 Sept.66	Untyped	-
E 715-7	Sylvia curruca	16 Sept.66	Tete group	+
E 718-9	Sylvia curruca	16 Sept.66	Tete group	
E 788-91	Luscinia luscinia	20 Sept.66	Tete group	+
E 807-10	Sylvia communis	20 Sept.66	Tete group	+
E 811-3	Sylvia communis	20 Sept.66	Tete group	+
E 814-7	Sylvia communis	20 Sept.66	Tete group	+
E 822-6	Sylvia communis	20 Sept.66	Tete group	+
E 890-3	Sylvia curruca	20 Sept.66	Simbu group	-
E 1004-7	Phoenicurus phoanicurus	23 Sept.66	Tete group	
E 1012-3	Phoenicurus phoenicurus	23 Sept.66	Tete group	+
E 1033-8	Sylvia communis	23 Sept.66	Tete group	
E 1268-9	Sylvia borin	30 Sept.66	Tete group	+
E 1325-3	Phylloscopus trochilus	30 Sept.66	Teta group	-
E 1509-14	Sylvia communis	7 Oct. 66	Tete group	-
E 1528-35	Phylloscopus trochilus	7 Oct. 66	Tete group	+
E 1566-8	Sylvia communis	10 Oct. 66	Tete group	
E 1586-97	Phylloscopus trochilus	10 Oct. 66	Teta group	+
E 1769	Sylvia borin	21 Oct. 66	Tete group	
E 1905	Sylvia atricapilla	4 Nov. 66	Tete group	
E 1986-93	Phylloscopus collybita	4 Nov. 66	Tete group	
E 2178-83	Phylloscopus collybita	11 Nov. 66	Teta group	+
E 2190-6	Phylloscopus collybita	11 Nov. 66	Teta group	-
E 2239-47	Phylloscopus collybita	11 Nov. 66	Tata group	
E 2623-5	Chloris chloris	20 Nov. 66	Tata group	+

Egypt and Cyprus Bird Isolates

Serum No.	Species	Date	Virus	Reisolation
E 3002	Turdus philomelos	11 Mar. 67	Tete group	
E 3127	Falco naumanni	24 Mar. 67	E 3127	
E 3235-7	Anthus pratensis	25 Mar. 67	E 3235-7	
E 3505	Tyto alba	3 Apr. 67	E 3505	
E 4204-5	Hirundo rustica	1 May 67	Tete group	
C 40	Saxicola rubetra	26 Sept.67	C 40	
C 45	Streptopelia turtur	29 Sept.67	C 40	
C 68	Saxicola rubetra	30 Sept.67	Tete group	+
C 93-6	Sylvia curruca	6 Oct. 67	Tete group	+
C 104	Phoenicurus phoenicurus	10 Oct. 67	Tete group	-
C 119-20	Phoenicurus phoenicurus	10 Oct. 67	Tete group	+
C 125-6	Phoenicurus phoenicurus	10 Oct. 67	C 40	
C 210-1	Sylvia curruca	16 Oct. 67	Tete group	+
C 649-55	Phylloscopus collybita	7 Nov. 67	Tete group	
Q 3255	Streptopelia turtur	18 Apr. 68	Q 3255	+
Q 3488-9	Muscicapa striata	30 Apr. 68	Ingwavuma	+
Q 3490-1	Muscicapa striata	30 Apr. 68	Ingwavuma	-
Q 3574-5	Sylvia nisoria	2 May 68	West Nile	-
E 5020	Sylvia communis	9 Sept.68	Tete group	-
E 5028	Sylvia communis	9 Sept.68	Tete group	-
E 5031	Sylvia communis	9 Sept.68	Tete group	+
E 5136	Luscinia megarhynchos	11 Sept.66	Tete group	
E 5207	Muscicapa striata	13 Sept.68	Tete group	
E 5266	Sylvia rüppelli	13 Sept.68	Tete group	

Egypt and Cyprus Bird Isolates

Serum No.	Species	Date	Virus	Reisolation
E 5302	Sylvia communis	13 Sept.68	Tete group	+
E 5305	Sylvia communis	13 Sept.68	Tete group	+
E 5408	Sylvia curruca	16 Sept.68	Tete group	
E 5428	Sylvia curruca	16 Sept.68	Tete group	

Table 2

Bird sera tested for virus isolation and serology, fall 1966,

Bahig and Abu Rawash

Species	Virus isolation plus serology		Virus isolation no serology		Virus isolated
	No. HI positive / No. pools tested	Total Birds	No. Pools	Total Birds	
Acrocephalus arundinaceus	0/4	4			
Acrocephalus palustris	0/1	6	1	5	
Acrocephalus schoenobaenus	0/20	90	5	28	
Acrocephalus scirpaceus	0/2	7	1	2	
Anthus cervinus			1	1	
Anthus trivialis	0/4	10	4	5	
Athena noctua			1	1	
Bubulcus ibis	1/7	7			
Caprimulgus europaeus	0/6	6	1	1	
Coracias garrulus	0/2	2			
Coturnix coturnix	0/59	70	2	2	
Crex crex	0/13	13	6	6	
Cuculus canorus	0/9	9	1	1	

TABLE 2 cont.

Bird sera tested for virus isolation and serology, fall 1966,

Bahig and Abu Rawash

Species	Virus isolation plus serology		Virus isolation no serology		Virus isolated
	No. HI positive / No. pools tested	Total Birds	No. Pools	Total Birds	
Erithacus rubecula	0/1	2	2	6	
Falco subuteo	0/1	1			
Falco tinnunculus	0/9	9	3	3	
Falco vespertinus	0/1	1			
Galerida cristata	0/1	1			
Gallinula chloropus	0/1	1			
Jynx torquilla	0/10	10	1	1	
Lanius collurio	0/61	92	7	9	E241
Lanius excubitor	0/3	3			
Lanius minor	0/2	2			
Lanius senator	0/2	2			
Luscinia luscinia	0/24	67			Tete group

TABLE 2 cont.

Bird sera tested for virus isolation and serology, fall 1966,

Bahig and Abu Rawash

Species	Virus isolation plus serology		Virus isolation no serology		Virus isolated
	No. HI positive / No. pools tested	Total Birds	No. Pools	Total Birds	
Luscinia megarhynchos	0/6	23	1	4	
Ixobrychus minutus	0/1	1			
Merops supercilious	0/1	1			
Monticola saxatilis	0/1	1			
Monticola solitarius			2	2	
Motacilla alba			7	7	
Motacilla flava	0/1	2			
Muscicapa striata	0/29	109	4	16	
Oenanthe hispanica	0/3	5			
Oenanthe isabellina	0/1	1			
Oenanthe oenanthe	0/7	7			
Oriolus oriolus	0/58	58	2	2	Tete group
Otus scops	0/1	1			

TABLE 2 cont.

Bird sera tested for virus isolation and serology, fall 1966,

Bahig and Abu Rawash

Species	Virus isolation plus serology: No. HI positive / No. pools tested	Virus isolation plus serology: Total Birds	Virus isolation no serology: No. Pools	Virus isolation no serology: Total Birds	Virus isolated
Passer domesticus	0/6	9	27	58	
Passer hispaniolensis	0/11	15	4	5	
Phoenicurus ochruros			1	2	
Phoenicurus phoenicurus	0/25	95			Tete grp.X2
Phylloscopus collybita	0/19	141	19	142	Tete grp.X4
Phylloscopus trochilus	0/25	189	2	19	Tete grp.X3
Porzana porzana	0/3	3	1	1	
Pycnonotus barbatus	0/3	3			
Saxicola rubetra	0/1	3	1	1	
Saxicola torquata			3	4	
Sturnus vulgaris	0/1	1			
Streptopelia senegalensis	0/1	1			
Streptopelia turtur	0/40	40	1	1	

TABLE 2 cont.

Bird sera tested for virus isolation and serology, fall 1966,

Bahig and Abu Rawash

Species	Virus isolation plus serology: No. HI positive / No. pools tested	Virus isolation plus serology: Total Birds	Virus isolation no serology: No. Pools	Virus isolation no serology: Total Birds	Virus isolated
Sylvia atricapilla	0/12	30	18	38	Tete group
Sylvia borin	0/17	44	8	16	Tete grp.X2
Sylvia cantillans			1	1	
Sylvia communis	0/25	123	3	14	Tete grp.X7
Sylvia curruca	0/28	113	10	44	Tete grp.X3 E890-3
Sylvia melanocephala	0/1	1			
Sylvia rueppelli	0/2	5	1	1	
Tringa ochropus	0/2	2			
Turdus merula	0/1	1			
Turdus philomelos	0/4	4	7	7	
Tyto alba	1/1	1			
Upupa epops	0/17	17	6	6	
TOTAL	2/597	1465	165	462	26

Table 3

Bird sera tested for virus isolation and serology, fall 1966,

Lake Manzala

Species	Virus isolation plus serology		Virus isolation no serology		Virus isolated
	No. HI positive/No. Pools Tested	Total Birds	No. Pools	Total Birds	
Anas crecca	0/1	1			
Anas penelope	0/2	2			
Carduelis carduelis	0/3	3	1	1	
Chloropus chloropus	0/3	3	2	2	
Fulica atra	12*/34	34	2	2	
Gallinula chloropus	12*/30	30	1	1	
Hydroprogne (tschegrava) caspia	0/1	1			

*Group B and Sindbis HI positive sera.

Table 3 cont.

Bird sera tested for virus isolation and serology, fall 1966,

Lake Manzala

Species	Virus isolation plus serology		Virus isolation no serology		Virus isolated
	No. HI positive / No. Pools Tested	Total Birds	No. Pools	Total Birds	
Nyroca ferina	0/1	1			
Porphyrio madagascariensis	0/1	1	1	1	
Rallus aquaticus	0/11	11	3	3	
Total	24/87	87	10	10	

Table 4

Bird sera tested for virus isolation and serology, fall 1966,

Port Said

Species	Virus isolation plus serology		Virus isolation no serology		Virus isolated
	No. HI positive / No. Pools Tested	Total Birds	No. Pools	Total Birds	
Acanthis cannabina	0/30	79	3	5	
Anthus spinoletta	0/1	2			
Calidris alpina	0/6	6			
Calidris minuta	0/4	9	1	3	
Carduelis carduelis	0/27	102	13	28	
Carduelis spinus	0/18	58	1	3	
Charadrius alexandrinus	0/8	13	6	9	
Charadrius hiaticula	0/1	1			
Chloris chloris	0/46	66	19	31	Tete group

Table 4 cont.

Bird sera tested for virus isolation and serology, fall 1966,

Port Said

Species	Virus isolation plus serology		Virus isolation no serology		Virus isolated
	No. HI positive / No. Pools Tested	Total Birds	No. Pools	Total Birds	
Fulica atra	0/5	5			
Gallinula chloropus	6*/31	31			
Lullula arborea	0/2	2			
Moticilla alba	0/2	2			
Passer hispaniolensis	0/3	3	2	2	
TOTAL	6/184	379	45	81	1

*Sindbis HI positive sera

TABLE 5

Bird sera tested for virus isolation, Egypt, Spring 1967

Species	No. Pools Tested	Total No. Birds	Virus isolated
Acrocephalus arundinaceus	12	14	
Acrocephalus palustris	1	3	
Acrocephalus scirpaceus	1	2	
Acrocephalus tentorius	1	1	
Anthus campestris	4	6	
Anthus cervinus	1	1	
Anthus pratensis	2	5	E 3235-7
Anthus trivialis	20	52	
Apus pallidus	1	1	
Athene noctua	7	7	
Bubulcus ibis	3	3	
Burhinus oedicnemus	2	2	
Burhinus senegalensis	1	1	
	8	14	
Calandrella cinerea	15	36	
	2	4	
Caprimulgus europeus	4	4	
Carduelis carduelis	1	1	
Chloris chloris	1	2	
Circaetus gallicus	2	2	
Corvus corone	7	7	
Coturnix coturnix	18	18	

TABLE 5 cont.

Bird sera tested for virus isolation, Egypt, Spring 1967

Species	No. Pools Tested	Total No. Birds	Virus isolated
Cuculus canoris	15	15	
Cursorius cursorius	2	2	
Delichon urbica	4	10	
Emberiza caesia	7	11	
Emberiza hortulana	2	3	
Erithacus rubecula	2	4	
Falco naumanni	18	18	E 3127
Falco tinnunculus	6	6	
Ficedula albicollis	13	36	
Ficedula hypoleuca	5	16	
Ficedula semitorquata	2	8	
Galerida cristata	15	16	
Gallinula chloropus	2	2	
Hippolais icterina	2	3	
Hirundo ripestris	1	1	
Hirundo rustica	10	16	Tete group
Jynx torquilla	22	31	
Lanius excubitor	1	1	
Lanius senator	15	21	

TABLE 5 cont.

Bird sera tested for virus isolation, Egypt, Spring 1967

Species	No. Pools Tested	Total No. Birds	Virus isolated
Luscinia luscinia	1	1	
Luscinia megarhynchos	30	63	
Merops apiaster	7	7	
Merops superciliosus	1	1	
Milvus migrans	1	1	
Monticola saxatilis	9	9	
Motacilla alba	2	2	
Muscicapa striata	16	41	
Oenanthe hispanica	6	13	
Oenanthe isabellina	5	7	
Oenanthe oenanthe	17	31	
Oriolus oriolus	17	17	
Otus scops	27	27	
Passer domesticus	6	10	
Passer hispaniolensis	19	45	
Phoenicurus ochruros	1	4	
Phoenicurus phoenicurus	33	96	
Phylloscopus bonelli	13	57	
Phylloscopus collybita	5	23	
Phylloscopus sibilatrix	15	61	
Phylloscopus trochilus	1	4	
Porzana porzana	2	2	
Pycnonotus barbatus	1	1	

TABLE 5 cont.

Bird sera tested for virus isolation, Egypt, Spring 1967

Species	No. Pools Tested	Total No. Birds	Virus isolated
Riparia riparia	3	9	
Saxicola rubetra	3	4	
Saxicola torquata	1	2	
Streptopelia senegalensis	9	9	
Streptopelia turtur	3	3	
Sturnus vulgaris	2	2	
Sylvia atricapilla	10	17	
Sylvia borin	16	32	
Sylvia cantillans	15	70	
Sylvia communis	20	59	
Sylvia curruca	9	30	
Sylvia melanocephala	1	2	
Sylvia nisoria	1	1	
Sylvia rueppelli	12	41	
Tringa glareola	1	1	
Tringa ochropus	1	1	
Turdus merula	3	3	
Turdus philomelos	19	20	Tete group
Tyto alba	4	4	E 3505
Upupa epops	39	41	
TOTAL	665	1280	5

TABLE 6

Bird sera tested for virus isolation, Cyprus, Fall 1967

Species	No. Pools Tested	Total No. Birds	Virus isolated
Accipiter brevipes	1	1	
Acrocephalus arundinaceus	3	3	
Acrocephalus palustris	5	13	
Acrocephalus scirpaceus	1	3	
Anthus trivialis	1	1	
Caprimulgus europoeus	1	1	
Carduelis carduelis	1	3	
Cuculus canorus	1	1	
Emberiza calandra	1	1	
Emberiza melanocephala	1	1	
Erithacus rubecula	18	45	
Falco tinnunculus	3	3	
Fringilla coelebs	5	9	
Galerida cristata	1	1	
Gallinula chloropus	1	1	
Jynx torquilla	1	1	
Lanius collurio	3	3	
Lanius nubicus	2	2	
Luscinia luscinia	2	2	
Luscinia megarhynchos	1	1	

TABLE 6 cont.

Bird sera tested for virus isolation, Cyprus, Fall 1967

Species	No. Pools Tested	Total No. Birds	Virus isolated
Merops apiaster	1	1	
Muscicapa striata	1	2	
Oenanthe sp.	14	16	
Oenanthe hispanica	1	1	
Oenanthe oenanthe	6	6	
Otus scops	6	6	
Passer domesticus	8	8	
Passer hispaniolensis	4	4	
Phoenicurus ochruros	1	3	
Phoenicurus phoenicurus	24	52	Tete group X3 C 40
Phylloscopus collybita	15	89	Tete group
Phylloscopus trochilus	23	69	
Porzana porzana	1	1	
Saxicola rubetra	4	4	C 40
Saxicola torquata	18	46	
Streptopelia turtur	7	7	C 40
Sturnus vulgaris	15	15	
Sylvia atricapilla	5	10	
Sylvia curruca	12	34	Tete group X2
Sylvia nisoria	3	3	

TABLE 6 cont.

Bird sera tested for virus isolation, Cyprus, Fall 1967

Species	No. Pools Tested	Total No. Birds	Virus isolated
Turdus merula	2	2	
Turdus philomelos	19	19	
Tyto alba	2	2	
TOTAL	245	496	9

TABLE 7

Bird Plasmas tested for virus isolation, Cyprus, Spring 1968

Species	No. Individuals Tested	Virus isolated
Accipiter nisus	2	
Acrocephalus arundinaceus	6	
A. schoenobaenus	2	
A. scirpaceus	18	
Anthus campestris	3	
A. cervinus	2	
A. pratensis	1	
A. trivialis	22	
Apus apus	1	
Ardea purpurea	1	
Asio flammeus	2	
A. otus	1	
Athene noctua	3	
Burhinus oedicnemus	1	
Caprimulgus europaeus	6	
Carduelis carduelis	1	
Circus macrourus	1	
Clamator glandarius	13	
Coracias garrulus	19	
Coturnix coturnix	1	
Cuculus canorus	25	

TABLE 7 cont.

Bird Plasmas tested for virus isolation, Cyprus, Spring 1968

Species	No. Individuals Tested	Virus isolated
Emberiza caesia	17	
E. calandra	25	
E. hortulana	13	
E. melanocephala	6	
Erithacus rubecula	26	
Erythropygia galactotes	1	
Falco columbarius	1	
F. naumanni	2	
F. subbuteo	1	
F. tinnunculus	28	
Ficedula albicollis	29	
Ficedula sp.	4	
Fringilla coelebs	1	
Galerida cristata	5	
Hippolais pallida	1	
Hirundo daurica	3	
H. rustica	3	
Ixobrychus minutus	1	
Jynx torquilla	24	

TABLE 7 cont.

Bird Plasmas tested for virus isolation, Cyprus, Spring 1968

Species	No. Individuals Tested	Virus isolated
Lanius collurio	28	
Lanius minor	2	
L. nubicus	22	
L. senator	1	
Luscinia luscinia	27	
L. megarhynchos	24	
Melanocorypha calandra	2	
Merops apiaster	1	
Monticola saxatilis	9	
M. solitarius	13	
Muscicapa striata	25	Ingwavuma X2
Oenanthe finschii	6	
Oe. hispanica	14	
Oe. isabellina	42	
Oe. oenanthe	27	
Oe. pleschanka	22	
Oriolus oriolus	18	
Otus scops	26	
Parus major	2	
Passer domesticus	25	
P. hispaniolensis	7	

TABLE 7 cont.

Bird Plasmas tested for virus isolation, Cyprus, Spring 1968

Species	No. Individuals Tested	Virus isolated
Phoenicurus ochruros	10	
Ph. phoenicurus	27	
Phylloscopus bonelli	9	
Ph. collybita	26	
Ph. trochilus	28	
Rallus aquaticus	1	
Saxicola torquata	10	
Streptopelia turtur	25	Q3255
Sylvia atricapilla	24	
S. borin	4	
S. cantillans	20	
S. communis	24	
S. curruca	25	
S. hortensis	27	
S. melanocephala	2	
S. melanothorax	7	
S. nisoria	23	West Nile
S. rueppelli	25	
Turdus merula	3	
T. philomelos	27	
Tyto alba	2	
Upupa epops	23	
TOTAL	1,037	4

Bird sera tested for virus isolation, Egypt, Fall 1968

Species	No. Individuals Tested	Virus isolated
Acanthis cannabina	1	
Acrocephalus arundinaceus	24	
Acrocephalus palustris	1	
Acrocephalus schoenobaenus	56	
Alaemon alaudipes	2	
Anthus trivialis	2	
Athene noctua	6	
Caprimulgus europaeus	2	
Cisticola juncidus	1	
Coracias garrulus	1	
Coturnix coturnix	8	
Crex crex	13	
Cuculus canorus	10	
Emberiza caesia	1	
Emberiza hortulana	1	
Erithacus rubecula	35	
Falco vespertinus	1	
Ficedula sp.	6	
Fringilla coelebs	2	
Galerida cristata	3	
Gallinula chloropus	1	
Hippolais icterina	16	
Hirundo rustica	4	

TABLE 8 cont.

Bird sera tested for virus isolation, Egypt, Fall 1968

Species	No. Individuals Tested	Virus isolated
Ixobrynchus minutus	1	
Jynx torquilla	15	
Lanius collurio	45	
Lanius minor	7	
Lanius senator	4	
Locustella flaviatilis	3	
Locustella luscinoides	1	
Luscinia luscinia	39	
Luscinia megarhynchos	32	Tete group
Merops apiaster	1	
Monticola saxatilis	1	
Monticola solitarius	2	
Motacilla flava	2	
Muscicapa striata	73	Tete group
Oriolus oriolus	1	
Passer domesticus	38	
Passer hispaniolensis	23	
Phoenicurus phoenicurus	72	
Phylloscopus collybita	56	
Phylloscopus sibilatrix	3	
Phylloscopus trochilus	67	
Porzana porzana	3	

TABLE 8 cont.

Bird sera tested for virus isolation, Egypt, Fall 1968

Species	No. Individuals Tested	Virus isolated
Streptopelia turtur	11	
Sylvia borin	45	
Sylvia cantillans	19	
Sylvia communis	54	Tete group X5
Sylvia curruca	47	Tete group X2
Sylvia nisoria	1	
Sylvia rueppelli	44	Tete group X1
Turdus iliacus	1	
Turdus philomelos	46	
Turdus pilaris		
Upupa epops	1	
TOTAL	855	10

TABLE 9

Sindbis HI reactors of bird plasmas, Cyprus, Spring 1968

Species	No. / No. positive / tested
Coracias garrulus	1/19
Jynx torquilla	1/24
Lanius collurio	2/28
Luscinia megarhynchos	1/24
Monticola saxatilis	1/9
Phoenicurus phoenicurus	1/27
Sylvia communis	1/24
Sylvia curruca	1/25
Sylvia hortensis	1/27
Upupa epops	1/23
73 Other Species	0/810

TABLE 10

Group B (probably West Nile) HI reactors of bird plasmas,

Cyprus, Spring 1968

Species	No. positive / No. Tested
Acrocephalus arundinaceus	2/6
Anthus trivialis	1/22
Emberiza calandra	1/25
Emberiza melanocephala	1/6
Erithacus rubecula	1/26
Falco tinnunculus	7/28
Lanius collurio	1/28
Lanius minor	1/2
Lanius nubicus	2/22
Monticola saxatilis	2/9
Oenanthe isabellina	2/42
Oenanthe oenanthe	1/27
Oenanthe pleshanka	1/22
Oriolus oriolus	2/18
Otus scops	1/26
Phylloscopus bonelli	1/9
Phylloscopus collybita	1/26
Phylloscopus trochilus	1/28
Streptopelia turtur	8/25
Sylvia atricapilla	1/24

TABLE 10 cont.

Group B (probably West Nile) HI reactors of bird plasmas,

Cyprus, Spring 1968

Species	No. positive/ No. Tested
Sylvia communis	2/24
Sylvia curruca	3/25
Sylvia hortensis	2/27
Sylvia rueppelli	1/25
Sylvia nisoria	6/23
Turdus philomelos	1/27
Upupa epops	2/23
56 Other Species	0/445

TABLE 11

Ingwavuma HI reactors of bird plasmas, Cyprus, Spring 1968

Species	No. positive / No. Tested
Emberiza caesia	1/17
Oriolus oriolus	2/18
Sylvia borin	2/4
Sylvia hortensis	2/27
Sylvia melanothorax	1/7
78 Other Species	0/967

TABLE 12

Tete group HI reactors of bird plasmas, Cyprus, Spring 1968

Species	No. positive/ No. tested
Emberiza caesia	1/17
Emberiza calandra	1/25
Emberiza hortulana	2/13
Erithacus rubecula	1/26
Falco tinnunculus	1/28
Luscinia megarhynchos	2/24
Phylloscopus trochilus	1/28
Sylvia borin	4/4
Sylvia communis	1/24
Sylvia curruca	4/25
Sylvia hortensis	1/27
Sylvia nisoria	14/23
Turdus philomelos	1/27
70 Other Species	0/749

TABLE 13

Reference and other selected mouse-pathogenic viruses from birds under study at YARU

Virus	Strain	Source	Collection site	Isolated by	Date	Sero-group
Bahig	E 90	Oriolus oriolus	Egypt	YARU	9/2/66	Tete
-	E 241	Lanius collurio	Egypt	YARU	9/4/66	Ungrouped
Thimiri	E890-3	Sylvia curruca	Egypt	YARU	9/20/66	Simbu
-	E3127	Falco naumanni	Egypt	YARU	3/24/67	E3127
-	E3235-7	Anthus pratensis	Egypt	YARU	3/25/67	E3127
-	C 40	Saxicola rubetra	Cyprus	YARU	9/26/67	E3127
-	Q3255	Streptopelia turtur	Cyprus	YARU	4/18/68	EgAn 4996-63
Ingwavuma	Q3488-9	Muscicapa striata	Cyprus	YARU	4/30/68	Simbu
West Nile	Q3574-5	Sylvia nisoria	Cyprus	YARU	5/2/68	B
-	IbAn32897	Pool of 5 birds	Nigeria	UI	10/29/68	Tete
-	IbAn39652	Sylvia communis	Nigeria	UI	1969	EgAn1398-61
-	IbAn28946	Plesiositagra cucullatus (=Ploceus)	Nigeria	UI	7/20/68	Ungrouped
Matruh	EgAn1047-61	Sylvia curruca	Egypt	NAMRU-3	9/26/61	Tete
Kemerovo	EgAn1169-61	Phoenicurus phoenicurus	Egypt	NAMRU-3	9/27/61	Kemerovo

TABLE 13

Reference and other selected mouse-pathogenic viruses from birds under study at YARU

Virus	Strain	Source	Collection site	Isolated by	Date	Sero-group
-	EgAn1398-61	Coturnix coturnix	Egypt	NAMRU-3	1961	EgAn1398-61
Matariya	EgAn1477-61	Sylvia curruca	Egypt	NAMRU-3	10/8/61	Matariya
Burg el Arab	EgAn3782-62	Sylvia curruca	Egypt	NAMRU-3	10/15/62	Matariya
-	EgAn1825-61	Phylloscopus trochilus	Egypt	NAMRU-3	10/18/61	Uukuniemi
-	EgAn4996-63	Streptopelia turtur	Egypt	NAMRU-3	1963	EgAn4996-63
Thimiri	EgAn6165-63	Sylvia communis	Egypt	NAMRU-3	10/4/63	Simbu
Thimiri	I66414	Ardeola grayii	India	Vellore	8/23/63	Simbu
-	I66416	Nycticorax nycticorax	India	Vellore	10/14/63	Ungrouped
-	I66413	Myna bird	India	Vellore	3/4/63	Ungrouped
-	I66415	Corvus sp.	India	Vellore	8/23/63	Ungrouped
Ingwavuma	I633970	Ardeola grayii	India	Poona	12/11/63	Simbu
Navarro	Cali 874	Cathartes aura	Columbia	Cali	10/15/56	Ungrouped

TABLE 13

Reference and other selected mouse-pathogenic viruses from birds under study at YARU

Virus	Strain	Source	Collection site	Isolated by	Date	Sero-group
-	BeAn141106	Pyriglena leucoptera	Brazil	BVL	5/30/58	Ungrouped
Hilo	An 114	Sturnus vulgarus	USA	Yale-Taylor	6/21/57	Ungrouped
Tete	SA An3518	Ploceus spilonotus	S.Africa	SAMRI	2/5/59	Tete
Sumakh	540	Turdus merula	USSR	IPR	5/24/68	Under study

Table 14

EgB90 Ascitic Fluid (homologous 1:128) Negative by CF with the listed viruses.

Acara
Akabane
Anhanga
Anopheles B
Aruac

BeAn84381
BeAn67949
BeAn14106
Bertioga
Bhanja
Boracea
Bujaru
Bushbush
Buttonwillow
Bwamba

Cali 874
California
Candiru
Capim
Chaco
Chagres
Changuinola
Chandipura
Chenuda
CoAr3627
Cocal
Congo
Corriparta
Cotia
Colorado tick fever

Dugbe

EgAn890-3
EgAn1398-61
EgAn3782-62
EgAn1825-61
EHD-New Jersey
Eretmapodites 147

Farallon

Ganjam
Grand Arbaud
Guajara
Guama
Guaroa

Hart Park
Hughes

I 66413
I 66415
I 66416
Iran 58
Ib An 10065
Ib An 15736
Ib An 17143
Ib An 17854
Ib H 11306
Icoaraci
Ieri
Ingwavuma
IPD A/401
Itaporanga

Johnston Atoll

Jurona

Kaisodi
Kamese
Kemerovo
Kern Canyon
Ketapang
Koongol

Lagos Bat

Klamath
Marco
Juan Dias
Melao
Mirim
Mossuril
Mt. Elgon

Naples
Nkolbisson
Nyamanini
Nyando

Oropouche
Olifantsvlei

Pacui
Pak Arg 461
Panama J 19
Panama J 134
Patois
Pichinde
Piry
Palyam
Punta Toro

Qalyub
Quaranfil

Lebombo
Sathuperi
Sawgrass
SH 763
Silverwater
Simbu
Soldado
Sud Ar 1275-64

Tacaiuma
Tamiami
Tataguine
Tembe
Thogoto
Triniti

Umbre
Uukuniemi

VS-Indiana
VS-New Jersey

Wad Medani
Wanowrie
Witwatersrand

Yaba-1

Herpes simplex
LCM
Rabies
Vaccinia
NDV

Table 15

Ascitic fluids tested by HI with EgB90 Antigen with negative results

chikungunya	Panama J 19	Utinga
o'nyong-nyong	I 66413	Icoaraci
Una	Ib An 10065	Chagres
IbH10964	Eg An 1825-61	Bunyamwera
EgAn1398-61	Eg An 1477-61	Anhanga
I 6234	IPD A/611	Bujaru
Eth Ar1846-64	Ib An 17143	Maguari
I 66415	Eretmapodites 147	Kairi
Ingwavuma	I 66414	Iran 58
Sud Ar 1275-64	MRM 4059	Guaroa
Ib H 10326	I 66416	Guajara
Eubenangee	Dakar 288	Anopheles B
Sud Ar 1169-64	Ib An 2898	Bakau
Juan Dias	Kwatta	Akabane
Ib H 14130	Rabies	Batai
IPD A/401	Kowanyama	Bhanja
MVM 66-33	Dakar 301	California
I 66410	Mayaro	Germiston
Nkolbisson	Cali 874	Ilesha
Dengue -2	Mermet	Itaqui
Chandipura	Buttonwillow	Ketapang
Ib An 20433	Olifantsvlei	Murutucu
I 66412	Manzanilla	Patois

Neutralization of Tete group viruses from Egypt, Fall 1968

by Bahig and Matruh hyperimmune mouse ascitic fluids

Virus	Isolation Date	Titer Log LD_{50}	LNI with Bahig	LNI with Matruh	More closely related to
5020	9/9	4.3	1.9	2.8	Matruh
5028	9/9	3.9	2.1	2.8	Matruh
5131	9/9	3.7	2.4	≥3.2	Matruh
5136	9/11	4.4	>3.6	2.1	Bahig
5266	9/13	5.1	>4.2	2.7	Bahig
5302	9/13	4.2	≥3.4	2.4	Bahig
5305	9/13	4.5	≥3.6	1.9	Bahig
5408	9/16	3.7	2.5	≥3.2	Matruh
5428	9/16	3.1	0.4	≥2.5	Matruh
Bahig		3.7	2.7	1.4	-
Matruh		5.2	2.2	≥4.0	-

TABLE 17

Neutralization test comparison of 3 strains of Thimiri virus

Virus	Titer in Log LD_{50}	Log Neutralizing Index of ascitic fluid		
		E890-3	I66414	E6165-63
E890-3	4.6	$\geq$4.1	2.1	3.6
I66414	4.4	1.8	3.0	$\geq$3.7
E6165-63	3.7	2.7	$\geq$3.2	$\geq$3.2

TABLE 18

CF comparison of Cyprus and Egypt Bird isolates of group E3127

Antigens	Ascitic Fluids					
	C40	C45	C125-6	E3127	E3235-7	E3505
C40	32/512*	16/128	16/128	---	---	---
C45	32/512	8/32	16/32	---	---	---
C125-6	32/512	16/128	16/128	---	---	4/8
E3127	---	---	---	16/16	4/4	0/0
E3235-7	---	---	---	0/0	16/64	16/256
E3505	---	---	8/32	0/0	16/128	16/128
Normal	0/0	0/0	0/0	0/0	0/0	0/0

*Reciprocal of ascitic fluid titer over reciprocal of antigen titer.

Table 19

Identification of EgAn1169- 61 as Kemerovo virus

CF Tests

Mouse Ascitic Fluids

Antigens	Kemerovo	EgAn1169-61	Tribec
Kemerovo	512/256*	128/16	16/16
EgAn1169-61	512/64	128/64	32/64
Tribec	64/64	8/4	64/256
Normal	<4/<4	<4/<4	<4/<4

*Serum/antigen

Neutralization Tests

Log LD_{50} in

Virus	Normal AF	Kemerovo AF	EgAn1169-61 AF
Kemerovo	6.2	4.9(1.3 LNI)	4.8(1.4 LNI)
EgAn1169-61	5.7	3.4(2.3 LNI)	3.8(1.9 LNI)

Table 20

CF Relationships of EgAn1825-61
Uukuniemi and Grand Arbaud

Antigens	EgAn1825-61 AsF	Uukuniemi AsF	Grand Arbaud Serum
EgAn1825-61	128/256*	<4/<4	32/64
Uukuniemi	32/64	16/64	8/16
Grand Arbaud	<4/<4	<4/<4	256/>1024
Normal	<4/<4	<4/<4	<4/<4

*Ascitic fluid/antigen

Table 21

ANTIGENS USED IN CF TESTING OF

Eg An 1477-61, An 1398-61, and An 3782-62

Aus R8659
Aus B 8112
Acara
Akabane
Anhanga
Anopheles A
Aruac

BA 937
Bahig
Bandia
Batai
BeAn 84381
BeAn 67949
BeAn 141106
Bertioga
Bhanja
Bujaru
Bunyamwera
Bwamba

Cali 874
California
Conn An 114
Capim
Chaco
Chandipura
Changuinola
Chenuda
CoAr 3627
Congo
Cotia
Colorado tick fever

Dugbe

Eg An 3782-62
Eg An 1398-61
EHD-NJ
Eretmapodites 147

Eg An 1825-61
Eubenangee
Eg An 1477-61

Farallon

Hart Park

Ganjam
Germiston
Grand Arbaud
Guama
Guaroa

Hazara
Hughes

Ieri
Ilesha
Ingwavuma
Iran 58
Iran 81

I 10658
I 61-2629
I 66-415
IPD A/401

Ib An 8341
Ib An 2898
Ib An 10065
Ib An 28946
Ib An 15736
Ib An 17143
Ib An 17854
Ib H 11306

Pan J 19
Pan J 134

Johnston Atoll
Junin
Jurona

Kaisodi
Kamese
Kemerovo

Lagos bat

Matucare
Microtus 1056
Marco
Melao
Mex 67 μ 5
Mirim
Mossuril
Mt. Elgon

Naples
Nepuyo
Nkolbisson
Nyamanini

Olifantsvlei
Oropouche

Pacui
Pak Arg 461
Pak T 487
Palyam
Pichinde
Punta Toro

Qalyub
Quaranfil

Sathupari
Sawgrass

Sicilian
Simbu
Soldado

Tacaiuma
Tamiami
Tataguine
Tete
Thogoto
Tribec

Umbre
Utinga
Uukuniemi

VS-Indiana
VS-NJ

Wad Medani
Wanowrie
Witwatersrand
Wongal

Yaba-1

Herpes simplex
LCM
NDV
Rabies
Ectromelia
Reo 3

TABLE 22

Antigens used in CF testing I66413, I66415, I66416, IbAn28946, BeAn141106, Cali 874, and An 114

Aus R8659	Eg An 890-3	Junin	Quaranfil
Aus B8112	Eg An 1398-61	Jurona	
Acara	EHD-NJ	Kairi	Sathuperi
Akabane	Embu	Kaisodi	Sawgrass
Amapari	Eretmapodites 147	Kamese	SH 763
Anopheles B	Eg An 1825-61	Kemerovo	Sicilian
Apeu	Eubenangee	Kern Canyon	Silverwater
Aruac		Ketapang	Simbu
	Farallon	Koongol	Soldado
BA 937		Kwatta	Sororoco
Bahig	Hart Park		
Bakau		Lagos bat	Tacaiuma
Bandia	Ganjam	Lanjan	Tacaribe
Batai	Grand Arbaud	Lebombo	Tamiami
BeAn 84381	Guajara	Lonestar	Tataguine
BeAn 67949	Guama	Lukuni	Tembe
BeAn 100049	Guaroa		Tete
BeAn 141106		Microtus 1056	Thogoto
Bertioga	Hughes	Mapputa	Timbo
Bhanja		Marco	Tribec
Boracea	Ieri	Melao	Triniti
Bujaru	Ilesha	Mex 67 μ 5	Trivittatus
Bunyamwera	Ingwavuma	Minnal	Turlock
Buttonwillow	Iran 58	Mirim	
Bwamba	Iran 81	Mossuril	Umbre
	Itaporanga	MRM 4059	Uukuniemi
Upolu		Mt. Elgon	
	I 10658	Murutucu	VS-Indiana
Cali 874	I 61-2629		VS-NJ
Conn An 114	I 66-415	Naples	
Candiru	I 66417	Nepuyo	Wongal
Capim		Nkolbisson	
Caraparu	IPD A/401	Nyamanini	Yaba-1
Aus CH 9824	Ib An 2898	Olifantsvlei	Herpes simplex
	Ib An 10065	Oropouche	LCM
Chaco	Ib An 28946		Ectromelia
Chagres	Ib An 15736	Pacui	Reo 3
Chandipura	Ib An 17143	Pak T 487	
Changuinola	Ib An 17854	Palyam	
Chenuda	Ib H 11306	Patois	
CoAr 3627		Pichinde	
Cotia	Pan J 134	Piry	
Colorado tick fever	Pan J 19	Punta Toro	
	Johnston Atoll		
Dugbe		Qalyub	

ANTIGENIC GROUP | YEAR OF ORIGINAL ISOLATION | COUNTRY OF ORIGINAL ISOLATION | FILTERED | SIZE | ENVELOPE | CAPSID | OTHER INFO | RNA | DNA | ETHER SENS | SDC(DCA) SENS | OTHER | HA PRODUCED | VIRUS RECOVERED FROM | MAN | FLUIDS AND TISSUES | OTHER VERTEBRATES | ALL STRAINS

LABORATORY METHODS OF VIRUS ISOLATION (ALL STRAINS) | ANIMALS AND EMBRYOS | CELL CULTURE | ARTHROPODS | VERTEBRATES | VIRUS ISOLATION | EVIDENCE OF INFECTION IN NATURE | ANTIBODIES | SENTINEL ANIMALS | ARTHROPODS | SUSCEPTIBLE TO EXPERIMENTAL INFECTION | VERTEBRATES | LABORATORY ANIMALS | SUBJECT TO NATURAL INFECTION | CELL CULTURE | HISTOPATHOLOGY | HUMAN DISEASE | LABORATORY INFECTION | GEOGRAPHIC DISTRIBUTION

TABLE 23

BAHIG

NO. 237

I Virus Name and/or Number: Bahig (Eg B 90)
Information from: Robert E. Shope — Day 10 Mo. 7 Yr. 1969
Address: Yale Arbovirus Research Unit, 60 College St., New Haven, Conn. 06510

II Antigenic Group: Tete (Bunyamwera Supergroup) Ungrouped (see details 2nd page)

III Original Source: Isolated by Smithsonian Field team in collaboration with YARU at New Haven, Conn.
Genus and Species: Oriolus oriolus — Sentinel Animal
Age or Stage: Adult, skull ossified — Sex: Not determined
Isolate from: Whole blood — Clot — Serum or plasma X — Other Fluids
Organs and Tissues
Signs and Symptoms of Illness: None

Time of Collection: Day 2 Month Sept. Year 1966 (bled the same day).
Method of Collection: Netted
Place Collected: Bahig Village, Matruh Governate, U.A.R. Lat 31°N Long 30°E
Macrohabitat: Irrigated garden oasis in semi-desert
Microhabitat:
Method of Storage Until Inoculated: -60°C, sealed ampoule.

IV Method of Isolation in Laboratory: Inoculation Day 22 Month September Year 1966
Animal Used: Swiss mouse — Age 3 day — Embryonated egg
Diluent: None — Inoc. 0.015 ml — Route Inoc. i.c.
Cell Culture: Type of Cell — Primary — Continuous Line
Diploid — Medium composition
Manner of Recognition: CPE — Plaques — Other

V Validity of Isolation: Reisolation: Yes X No Not Tried
Homologous Antibody Formation by Original Source Animal: Yes No Not Tested X
Tests Used: — Other Reasons Supporting Validity of Isolation:
New virus in laboratory

VI Properties of Virus
Physical: Filtered Yes — Type(s) Filter: Millipore, passed 220mμ, not 100mμ
Size: mμ How Estimated:
Envelope: Present — Diameter — mμ Absent
Capsid: Diameter mμ Shape — No. of Capsomeres
Other Information:
Chemical: RNA — DNA — Other Information

Resistance to Chemicals
Ether Tol — After Treatment Titer — Control Titer
Sod. deoxycholate Tol 1:500 — After Treatment Titer 2.0 — Control Titer 5.6 log LD_{50}/0.02 ml.
Other Chemicals

Antigenic Hemagglutinin Produced? Yes X No Not Tried
Source Material Used: Mouse brain
Methods Employed: Sucrose acetone, sonication
Source of Erythrocytes: Goose
pH Range 5.8 – 6.7 Optimum 5.9 — Temp. Range — Optimum: Rm. temperature
Remarks:

Name of Relationship and Lack of Relationship to Other Viruses: Related to SA An 3518 and EgAn 1047-61 (1)

CF

Antigens	Eg B 90 As.F.	Eg An 1047-61 serum	Tete SA An 3518 As.F.
Eg B 90	>128	64	4
Eg An 1047-61	>128	64	4
SA An 3518 (Tete)	32	4	32

HI

	Eg B 90 As.F.	Eg An 1047-61 serum
Eg B 90	2560	40
Eg An 1047-61	80	640

Eg B 90 ascitic fluid (homologous 1:128) did not fix complement with 117 arbovirus antigens and herpes, LCM, Rabies, vaccinia, and NDV. Eg B 90 HA antigen was not inhibited by 70 ascitic fluids of arboviruses. Further HI tests showed inhibition by a Simbu grouping fluid (1:20) and by typing fluids (1:10 or 1:20) of Simbu, Ingwavuma, Manzanilla, Mermet, Buttonwillow, Bwamba, California, and Bunyamwera.

NOT REPRODUCIBLE

Methods Found Most Useful for Investigating Antigenic Characteristics: CF for grouping, HI for typing.

Biologic Characteristics
Virus Recovered From (all isolations from vertebrates): Blood (M) (LV) X — Cerebrospinal fluid (M) (LV) — CNS (M) (LV) — Heart (M) (LV) — Lung (M) (LV) — Liver (M) (LV)
Spleen (M) (LV) — Kidney (M) (LV) — Skin lesions (M) (LV) — Nasopharyngeal (M) (LV)
Milk (M) (LV) — Urine (M) (LV) — Feces (M) (LV) — Salivary gland (M) (LV)
Mammary gland (M) (LV) — Lymph node (M) (LV) — Skeletal muscles (M) (LV)
Other
Laboratory Methods of Virus Recovery (all isolations): Suckling mice X — Weanling mice
Baby chicks — Embryonated eggs — Hamster — Rabbit — Guinea pig — Primate — Other animals

Cell Cultures: Human (P) (L) — Other primate (P) (L) — Other mammal (P) (L) — Avian (P)
(L) — Other

TABLE 23 cont.

Natural Host Range

Vertebrate and Arthropod	No. Isolations/No. Tested	Country and Region	No. with antibody/No. Tested Test Used	Country and Region
Sylvia communis	11[a]	Egypt and Cyprus A total of 3700 migratory birds were examined.		
Sylvia curruca	6			
Sylvia borin	2			
Sylvia atricapilla	1			
Sylvia rupelli	1			
Phylloscopus collybita	5			
Phylloscopus trochilis	3			
Phoenicurus phoenicurus	4			
Oriolus, Lanciuis, Chloris, Turdus, Hirundo, Saxicola, Muscicapa.	1 each			

[a] These isolates are closely related by CF to Eg S 90 but may represent different types such as Eg An 1047-61 (1).

Susceptibility to Experimental Infection: Vertebrates, Embryos, Arthropods, and Cell Cultures(TC)

Experimental Host	Passage History Strain Used	Age of Animal or Egg	Inoculation Route ml	Evidence of Infection	AST Days	Titer (Log) per ml
Mice	1 mouse	1-4 day	ic 0.02	Death	3.4	7.1(pass. 3)
"	2 "	1-4 "	ip 0.02	5/8 died with 10% brain		
"	2 "	3-4 week	ic 0.03	1/8 died (paralyzed)		
"	2 "	3-4 "	ip 0.1	antibody		
VERO cell culture (Dr. S. Buckley)	1 "			Granulation & rounding of cells		7.5

Histopathology: Character of lesions

Inclusion Bodies: Cytoplasmic (M) ___ (LV) ___ Intranuclear (M) ___ (LV) ___

Organs and Tissues Significantly Affected: Brain(M) ___ (LV) ___ Spinal cord (M) ___ (LV) ___
Lungs(M) ___ (LV) ___ Liver(M) ___ (LV) ___ Spleen(M) ___ (LV) ___ Kidney(M) ___ (LV) ___ Heart(M) ___ (LV) ___
Blood vessels(M) ___ (LV) ___ Marrow(M) ___ (LV) ___ Skeletal muscles(M) ___ (LV) ___ Secretory glands(M) ___ (LV) ___

Species of lower vertebrates (LV) used in study ___

Category of Tropism ___

Human Disease: In nature: (R) ___ (S) ___ Death(R) ___ (S) ___ Residua(R) ___ (S) ___

Laboratory Infection: Subclinical(R) ___ (S) ___ Overt disease(R) ___ (S) ___

Clinical Manifestations: Fever(R) ___ (S) ___ Headache(R) ___ (S) ___ Prostration(R) ___ (S) ___ Conjunctival inflammation(R) ___ (S) ___ Stiff neck(R) ___ (S) ___ Myalgia(R) ___ (S) ___ Arthralgia(R) ___ (S) ___ CNS signs (including encephalitis)(R) ___ (S) ___ Hemorrhagic signs(R) ___ (S) ___ Respiratory involvement(R) ___ (S) ___ Leukopenia(R) ___ (S) ___ CNS Pleocytosis(R) ___ (S) ___ Rash(R) ___ (S) ___ Lymphadenopathy(R) ___ (S) ___ Jaundice(R) ___ (S) ___ Vomiting(R) ___ (S) ___ Other significant symptoms ___

Category: (see instructions reverse side) 1)Febrile illness ___ 2)Febrile illness with rash ___ 3)Hemorrhagic fever ___ 4)Encephalitis ___

Number of Cases Observed: ___

Known Geographic Distribution: Virus Isolation: Egypt; also probably Europe since birds arrive viremic in Egypt from Europe.

Suspected Geographic Distribution: (from serological surveys) Egypt, Cyprus, Israel

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Remarks:

NOT REPRODUCIBLE

Publications

The publications thus far of the Palearctic Migratory Bird Survey have been largely short, preliminary presentations of information or progress reports intended to elicit further data. This is particularly true of the accounts of banding in The Ring (Hubbard 1967a, 1967b; Hubbard and Horner 1969, and Watson 1970). The other Palearctic banding programs are well aware of our activities and have offered assistance and information.

New bird records from Egypt (Hubbard and Seymour 1968) and Cyprus (Hubbard 1969) have already been published. Although the virological results of the Hubbards' trip to Uganda in spring 1968 were disappointing (Hubbard and Henderson 1969), they published a note on flycatcher feeding behavior (Hubbard and Hubbard 1970). An unpublished report on bird liming in Cyprus by Dr. Hubbard has influenced conservation in that country.

A paper summarizing PMS results that was read in Novosibirsk, USSR in 1969, where it was well received, constitutes the most significant contribution of the PMS so far. The paper, by Watson, Shope and Kaiser, is now in press. A short report was circulated by the Smithsonian Center for Short-lived Phenomena about a high rate of virus infection in *Sylvia communis* in spring 1969 (Watson 1969).

PMS virus data has already been incorporated into two theses (Mercer 1969 and Ryan 1970) and bird migration data will be used by Mr. Horner in a PhD program at Virginia Polytechnic Institute.

Two tick papers have been published, one describing a new species (Hoogstraal, Kaiser, Seymour and Gaber 1967; Kaiser, Hoogstraal and Horner 1970) and a third paper describing a new species is in preparation by Dr. Kaiser.

PMS data has been used in several other projects and publications (Watson 1969a, in press; Watson and Gray 1969). Mr. Horner and coauthors will shortly present all Egyptian band recoveries to date, in hopes that they will bring new records to light. Shope and Kaiser are preparing comprehensive reports on virus and tick findings, and Watson will include migration data in bird distribution checklists.

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In preparation

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Operation in Israel, Fall 1967 to Spring 1969

The report on the Israel portion of the Palearctic Migratory Bird Survey is presented separately for political but not for biological reasons. Throughout the project it became increasingly more difficult to work simultaneously in both Israel and Egypt. Although it was known to the Israeli collaborators that the PMS was operating in Egypt, no reciprocal information was volunteered for fear that the project would be expelled from Egypt. Unfortunately, it was also impossible to exchange personnel back and forth across borders nor for the field teams to compare data as it was collected. This meant that for two years, the PMS maintained two entirely separate bird trapping operations in the Eastern Mediterranean. No attempt was made at comparison of migration data for the two localities in the main body of the report, but preliminary comparisons are made between the abundance of a few species in this section.

When the June 1967 hostilities made it impossible to operate in Egypt, the PMS was granted permission to band birds and collect a limited number of specimens in Israel beginning in late fall of that year. It was not feasible to pursue an active blood collecting program in Israel, however, because of the strong conservation orientation of the local sponsors, Professor H. Mendelsohn and Dr. A. Zahavi of Tel-Aviv University, part of the field team that had worked in Cyprus earlier in the fall moved to Israel in mid November.

Banding

A banding station was set up at Maagan Mikhael, a fish culture kibbutz midway between Tel Aviv and Haifa on the Mediterranean coast. The area has been declared a nature preserve. The fish culture ponds proved attractive to waterfowl and shorebirds while a number of passerines were taken in the nearby scrub. That winter eight other banding sites were visited to evaluate their potential for spring operation and specimens were collected for reference and documentation. Birds were banded and specimens collected at the Ahada River (2 kilometers east of Caesarea), the Alexander River (2 kilometers east of Haifa), Allonai Ytzhak, Gan Shmoel (3 kilometers north of Hadera), the Hadera River on the coast road, Yotvata, Zikhron Ya'akov, and Eilat. The last locality proved best and all operations were moved to Eilat for the spring migration and all subsequent PMS banding in Israel through the spring of 1969. Banding was continued by Israeli personnel alone in 1970-1971 at the same site. Mr. and Mrs. Steven R. Peterson were the principal PMS banders. They were assisted by Miss Bruria Glovinsky and other Israeli aides.

Eilat (29° 33' N, 34° 57'E) is located in southernmost Israel on the Gulf of Aqaba. The area was selected for study because the truck vegetable gardens and date plantation (Figures 1 and 2) provide the first large green oasis in the desert for migrants travelling north along the Red Sea coast and across the Sinai Peninsula, or south over the Negev Desert and Araba Valley where only low scrub and a few acacia groves are found (Figures 3 and 4).

The results of the three seasons of banding are comparable because the

Figure 1. The nets set along hedge row near hay field.

Figure 2. Date palms at Eilat.

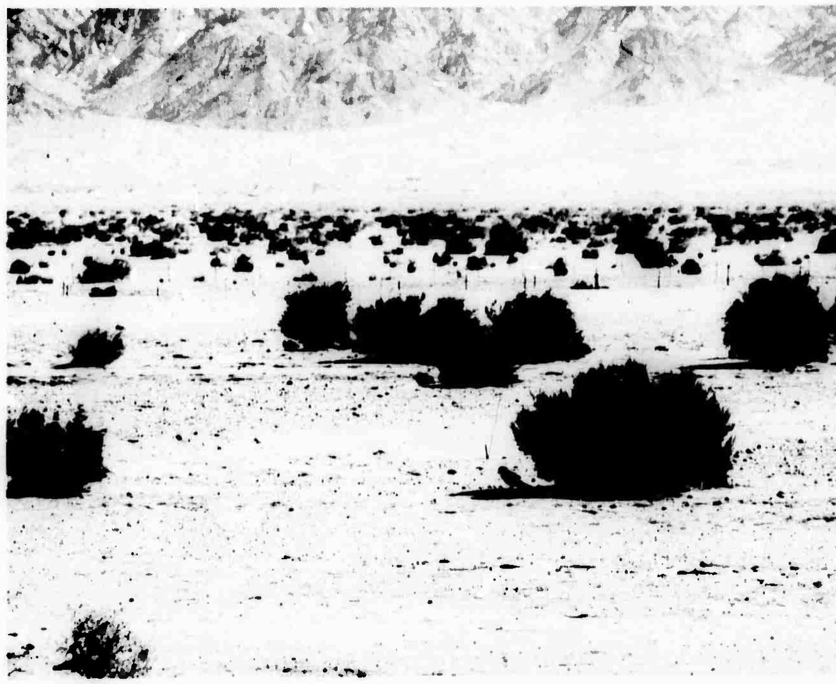

Figure 3. Desert scrub in southern Araba Valley near Eilat.

Figure 4. Acacia trees north of Eilat.

Figure 5. Seablite, *Suaeda monoica,* grove where birds were netted at Eilat.

number and placement of nets were approximately the same. Thirty to thirty-five mistnets were set up in low seablite, *Suaeda monoica*, groves (Figure 5) , in date groves (Figure 2), in hay fields, and along hedgerows of seablite and eucalyptus (Figure 1). The nets were opened before sunrise and visited regularly for five or six hours, depending on the heat or other weather conditions. All birds were brought into a central processing hut where they were identified, examined for ectoparasites, measured, banded and released. A few specimens of rare or unusual birds were collected, as were some samples for documentation of subspecies.

During the first season in Israel, the winter of 1967-1968, 993 birds of 50 species were banded. Banding was sporadic as many sites were tested. After the project was established at Eilat, banding volume increased. Spring, 1968 saw 9423 birds of 76 species banded at Eilat. That fall, 3363 birds representing 72 species were ringed. In spring 1969, the final season of PMS banding in Israel, 4172 birds of 73 species were banded. The distribution by species and by day during the seasons is shown in Appendix II.

In spring 1968, an average of 101 birds were banded daily during the 93 operational days. Two peaks were evident, both in the number of birds and in the number of species captured. These peaks coincided roughly in timing and occurred between March 25 and April 5, and between April 20 and May 5. The maximum number of birds handled during one day was 512 on April 25. After this, birds decreased rapidly in the study area until by the end of May less than 10 birds a day were being taken. Numbers of species were highest during the first peak, with a high of 29 species on

March 27. At the beginning of the season more than 10 species were taken each day, but by the end of May an average of less than three species were caught daily.

During the fall of 1968, 3363 birds of 72 species were banded at Eilat. An average of 34.6 birds were banded daily during the 97 days of operation. These numbers are far less than the spring totals, and corroborate prior observation of far fewer migrants in fall. Numbers of birds gradually increased until mid-October, but by the first week in November, numbers decreased rapidly to a relatively low wintering population. This single broad peak, recorded during the fall, was much different from the prominent two-peaked migration observed in the spring. In general, the same species passed through Eilat in the fall of 1968 as in the spring, but in different numbers. Fifty-nine species were banded in both spring and fall. Eighteen species banded in the spring were not recorded in the fall, and 13 species not banded in spring were netted in the fall. *Passer moabiticus, P. hispaniolensis, Luscinia svecica* and *Acrocephalus scirpaceus* were the most commonly caught fall birds; whereas in spring of 1968, *Sylvia atricapilla, S. curruca, Passer hispaniolensis* and *Phylloscopus collybita* were caught most often.

In the spring of 1969, 4172 birds of 73 species were banded at Eilat. An average of 46.3 birds were handled daily for the 90 days of operation. *Sylvia atricapilla, S. curruca, Passer moabiticus, Riparia riparia* and *Anthus trivialis* were the most frequently captured birds. The same species passed through Eilat in spring 1969 as in spring 1968, but only about half the numbers banded in spring 1968 were banded in 1969. Peaks in migration were not as evident in 1969 as in 1968, but there appeared to be a broad peak between the last week in March and the middle of April. Numbers of *Sylvia atricapilla* and *Sylvia curruca* were much higher in 1968 than 1969, but *Passer moabiticus* was much more common in 1969.

Some conspicuous differences show up when the Israel migration data are compared in gross fashion with the Egyptian data. Some species that are common on one route are rare or absent on the others while for other species there are significant seasonal differences in abundance. A few of these apparent differences may merely be due to differences in methods of capture or differences in local habitat at the capture site. Among these are probably the falcons, quail, and doves which were captured in numbers in Egypt but were rare in the Israel samples. These species require special methods of capture and are favored by the Bedouins. The ground dwelling *Motacilla flava* and possibly *Anthus cervinus*, on the other hand, probably avoided the Bedouin's tree nets in Egypt but were captured easily in mistnets in Israel.

Species that were common in Egypt at one or both seasons but were markedly less common or rare in Israel were: *Cuculus canorus*, *Upupa epops*, *Calandrella cinerea*, *Lanius collurio*, *Lanius minor*, *Hippolais icterina*, *Sylvia communis*, *S. rueppelli*, *S. cantillans*, *Phylloscopus sibilatrix*, *Ficedula albicollis*, *F. hypoleuca*, *Muscicapa striata*, *Phoenicurus phoenicurus*, *Turdus merula*, *T. philomelos*, *Passer domesticus* (*resident*), and *Oriolus oriolus*.

Species that were common in Israel at one or both seasons but were markedly less common or rare in Egypt were: *Hirundo rupestris*, *H. daurica*, *Lanius nubicus*, *Hippolais pallida*, *Luscinia svecica*, *Emberiza melanocephala* (winters in India), *Passer hispaniolensis* and *P. moabiticus* (migrates only locally in Middle East, doesn't reach Egypt).

Species that were more common in fall in Egypt and in spring in Israel were *Jynx torquilla, Acrocephalus schoenobaenus, Sylvia atricapilla, S. curruca,* and *Phylloscopus collybita.*

Those more common in fall in Egypt, and in both seasons in Israel were *Acrocephalus scirpaceus* and *Phylloscopus trochilus;* while *Erithacus rubecula* and *Luscinia luscinia* were also common in fall in Egypt but rare in Israel in both seasons. *Delichon urbica* was also rare in Israel but common in spring in Egypt while *Riparia riparia* was also common in spring in Egypt, but present in Israel in both seasons. Those more common in spring in Israel and in both seasons in Egypt were: *Hirundo rustica, Sylvia borin* and *Luscinia megarhynchos*.

After banding by PMS personnel ceased in spring 1969, because the field head returned to graduate school, and because of security problems, banding was suspended until spring 1970 when Miss Bruria Glovinsky and Dr. Uriel Safriel resumed banding at Eilat. In spring 1970 they banded 10,211 birds of 79 species.

Thus far, the following bands from birds banded in Israel in 1968 and 1969, have been recovered:

Species	Number	Banded in	Recovered in
Anas crecca	1	Israel	Egypt
Coturnix coturnix	1	Israel	Egypt
Calidris alpina	1	Israel	Egypt
Sylvia atricapilla	1	Israel	Cyprus
Phoenicurus phoenicurus	1	Israel	Cyprus
Passer hispaniolensis	1	Israel	Egypt

Three other Egyptian recoveries of birds banded in Israel in 1970 are not yet fully documented. They consist of one *Phylloscopus bonelli* and two unidentified species.

Ectoparasites

All birds handled were examined for ectoparasites. In the spring of 1968, 323 birds of 9423 handled were infested (3.5%); in the fall of 1968, 149 birds of 3363 (4.5%); in the spring of 1969, 140 birds of 4172 (3.3%). Ectoparasites from Israel have been identified by other than PMS personnel: Dr. Carlton Clifford of the Rocky Mountain Laboratory (U.S. Public Health Service), has provided tick identifications and Dr. K. C. Emerson (Research Associate, Smithsonian Institution), the Mallophaga identifications; while the rest of the material collected hippoboscid flies, fleas, and mites, has been distributed to experts but not yet reported. Thus far, of the 612 ectoparasite collections made, 513 have been identified as ticks, the rest being mainly Mallophaga. The ticks and bird species are shown in Table 1.

Summarized weekly infestation rates changed throughout the season. In 1968, infestation peaked twice, March and May, during the spring migration season; but only once in the fall, infestation increasing to the peak as the autumn migration progressed. Little infestation was found in seedeaters and aerial insectivores. Birds found to be heavily infested in the spring were: *Anthus trivialis, Oenanthe hispanica, Oenanthe oenanthe, Phoenicurus phoenciurus, Hirundo rustica* and *Sylvia curruca.* Heavily infested fall species were: *Passer hispaniolensis, Passer moabiticus, Anthus trivialis,* and *Luscinia svecica.*

TABLE I

ISRAEL TICKS SPRING 1968

Hyalomma marginatum rufipes
From:

Cuculus canorus
Anthus campestris
" *trivialis*
" *pratensis*
" *cervinus*
Motacilla flava
" *alba*
Lanius nubicus
" *senator*
" *excubitor*
Locustella luscinioides
Acrocephalus schoenobaenus
" *palustris*
" *scirpaceus*
" *arundinaceus*
Hippolais pallida
Sylvia nisoria
" *hortensis*
" *borin*
" *atricapilla*
" *communis*
" *curruca*
" *rueppelli*
Phylloscopus collybita
" *bonelli*
Ficedula albicollis
" *albicollis/hypoleuca*
Saxicola torquata
Oenanthe oenanthe
" *hispanica*
" *isabellina*
Cercotrichas galactotes
Phoenicurus phoenicurus
Luscinia megarhynchos
" *luscinia*
Cyanosylvia svecica
Emberiza melanocephala
Passer hispaniolensis
" *moabiticus*
Oriolus oriolus

Haemaphysalis punctata
From:

Anthus trivialis

Amblyomma sp.
From:

Anthus trivialis
Acrocephalus arundinaceus

Blood-collections

Serum samples were only collected on four days March 19-22, 1968 because the technician was urgently needed for an unexpectedly heavy volume of work in Cyprus. A total of 42 blood samples from 67 individuals of 11 species of birds were collected and sent to YARU for processing. No virus was isolated from any of these samples.

Specimen collections

During the two years in Israel 702 reference specimens of migrants and residents were collected for the Smithsonian collections. These included 298 study skins, 155 skeletons and 249 alcoholic specimens. Among the more important specimens collected were one wintering *Anthus trivialis* (first winter record for Israel), six *Carpodacus erythrinus* (no previous Israel records), 2 *Ficedula parva* (rarely recorded migrant), 1 *Sylvia nana* (a rare resident in Israel) 3 *Emberiza rutila* (no previous Israel records), and a photograph of 2 *Charadrius asiaticus* (second sighting in Israel). Mr. Peterson will author a note on these new and unusual records.

Final Comments

Considerable recovery problems are encountered in bird banding in a state surrounded by hostile neighbors. It is probably impossible to recover Israel bands from natives in any of the surrounding Arab countries. The few bands reported found in Egypt were recovered by the PMS. In order to remedy this situation the Israel banders requested a central reporting station and return address in Europe (eg. Paris) but were turned down by Euring which did not want to hurt its relations with Arab collaborators.

The Principal Investigator was requested by NAMRU-3 in Cairo to sever all formal research contact with Israeli scientists, if he wanted to continue working in Egypt. This was accomplished during 1970 when formal direction for the PL 480 portion of the Israel project was turned over to Dr. Helmut K. Buechner of the Smithsonian Institution. Informal contact with the ongoing Israel bird banding is maintained through Dr. Buechner. In addition, it is intended that Mr. Steven Peterson (presently a graduate student in the Department of Zoology, University of Wisconsin) will collaborate in writing the banding results for publication with Miss Bruria Glovinsky and Dr. Uriel Safriel who have continued banding in 1971.